And Not a Drop to Spare:
WATER QUALITY AND QUANTITY ISSUES AND CURRENT POLICIES IN THE MEXICO CITY METROPOLITAN AREA, MEXICO AND THE WORLD

by
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The global community is facing hazardous water quality and quantity issues. These issues affect every human community in some way, and so it is important for the citizens of the world to understand these issues. The Mexico City Metropolitan Area is a prime example of many of the water quantity and quality issues that exist around the globe. There are many policies and programs that have been created there in hopes to slow down or solve some of the water issues. By examining the problems and the attempts that have been made to address them, we can gain knowledge of existing water problems. With such knowledge, we will be better able to understand and work towards solving similar water issues in other parts of the world so that humans can continue to survive using this very precious resource.

ACKNOWLEDGEMENTS

I would like to take a moment to thank all the people who helped me on my perilous journey through the thesis process. So to those people who fed me when I was hungry and who patiently listened at times when I was overwhelmed with words, thank you. To those who left the porch light on so I could find my way when I was feeling lost or who lent me a chair to sit in when I felt I couldn't go on, thank you. To those who prodded me on when they knew it was time for me to go and who helped remind me of the merits of ice cream and sexy minerals, thank you. To those who allowed me to spout wild theories and who laughed with me every chance they had, thank you. To those who would chauffeur me when the path looked too long and dangerous or offered me Kleenex and sympathy on the stormy days, thank you. To those people who let me be myself no matter what and who still think I'm worth hanging out with, thank you. I guess what I really want to do is to thank anyone who has enriched my life by giving me a piece of their own, which is what gave me the strength to stumble across the finish line after this long, hard walk.

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PREFACE

I have discovered that I must include this note of explanation in my thesis to clarify what my primary goals in writing this paper are. The correct subject heading for this document is a "creative thesis on a scholarly topic." It took me a long time to realize that this was what I was attempting to do, but I think this heading fits what I hope my end result will be. As the reader will notice, this is not a strictly formal paper. I have continuously attempted to bring the reader into the paper in order to remind her of what she has already learned and about what she has left to learn on the subject at hand. The reader is not to be just an observer, but must travel at my side through this information. I did not write this thesis just because the subject was there; instead, I wrote it to prove to myself and other lay people that it does not take an expert to understand and make conclusions about a complex and "scholarly" topic.

Do not think, reader, that this means I do not feel my topic is important in itself. Water quality and quantity issues are very important and very prevalent in the modern world, because all humans are or will be affected by them. I found this topic fascinating and I want to share that fascination with my peers. Too often throughout my journey through college and the academic world I have read papers on interesting topics that I could not wade through well enough to glean out the important information that I know they contained. I would get bogged down by overly complex language and ideas that were not fully explained. I firmly believe that such formal papers, though having a place in the world, must be at least balanced out by simpler papers that can be followed and understood more easily. I do not think this idea is popular in the academic world. But I insist that this is needed so that the general public, people such as myself, can look into the academic world and understand what is going on. Such papers are neither simplistic nor lack the information that more formal papers contain. Instead, these papers will be written for academics and non-academics alike, using less formal language that I believe is more easily understood.

I did not know a lot about the Mexico City Metropolitan Area when I started this project. I ended up knowing more than I thought I would. In my experience, this type of information is available to those who have the desire to access it. My research took me down many paths, and I will admit that I did not explore all these avenues fully. But in this way I have left room for the reader to go on beyond what I have done to make his own venture into unknown territories. More than anything I want the reader to remember that he, too, can make such a search, whether he is an "expert" or not. It is not only up to the scientists, industry, and academics to tell us what is happening and what should be done about issues of environmental degradation. The information is readily available in this country, just waiting for someone to access it and determine what is important.

It is these things that are my main goals for this thesis. Just finishing this paper is not enough for me; I want it to be accessible to all who are interested, young and old, and it is towards this end that I have struggled. I leave the reader with these thoughts as the adventure begins, and hope she stays at my side throughout. Good traveling.

CHAPTER ONE

Worldwide Water Issues

Water is a resource that is fundamental for human survival. Water also transcends any political boundary that we might invent. Like so many resources, water is being affected negatively by humans even as we depend on it for continued existence. From overconsumption to poor water quality, the loss of usable water is a serious matter and it affects humans around the globe. We must become aware of how precious this resource is and how seriously we are impacting it on a global level so that we can begin to work towards resolving some of the problems that exist. Without this awareness and an eventual change in methods of water use, we are facing a grim future. The first chapter of this thesis will be an outline of major water issues that humans are facing around the globe so the reader can gain an understanding for how extensive these issues are. These water quantity and quality issues are occurring all around the globe, not in any one specific area. The knowledge the reader will gain in this first chapter is fundamental to following the rest of the thesis, where I will do some closer examinations of water issues in particular areas.

After I introduce worldwide water issues to the reader, I will examine the water problems that the world faces by focusing on one area of the world. In the second chapter I will present the nation of Mexico to the reader, briefly outlining a few of the biggest water issues there. In the third chapter I will introduce the Mexico City Metropolitan Area (MCMA), which will be the main focus of my thesis. By exploring the MCMA and the water issues that this highly urbanized area faces, the reader will be able to gain an understanding of water problems that exist throughout the world more clearly. As a follow up to the initial presentation of water quality and quantity issues that exist in the MCMA, I will examine, in chapter four, the policies and programs being implemented by the Mexican government in an attempt to solve the water problems of the nation as a whole and the MCMA in particular. In the final chapter, I will give some of my impressions of what more can be done in the MCMA to address the water issues, as well as what I feel is working and what is not. I will also, to conclude the document, retreat from the MCMA and readdress global water issues. At this point I will discuss what other areas have similar problems to the MCMA, and how examining what is working there can possibly be used by other countries in their struggle to overcome such water issues. By the end of this document, I will have gone full-circle and the reader and I will have ended up back on a global scale, with a better understanding of water quality and quantity issues of the world, and what is being done to address them.

Before I begin discussing water quality and quantity issues and how humans interact with water, I want to discuss it on a more basic level. I cannot imagine a world without water because it is such an integral part of our lives in ways we might not even realize. For example, water in its solid form is less dense than in its liquid form. This allows ice to float on bodies of water. Why is this so remarkable? If ice sank, then the life that is preserved on our world in lakes and streams even through very cold winters would die out as organisms were crushed by sinking ice sheets. Also, it would be much more likely for bodies of water to freeze solid as layers of forming ice fell to the bottom, and there would be a shortage of water in some regions because of this. Another good example of the importance of water is that it needs a relatively high amount of heat energy to make it change state, from liquid to gas or from solid to liquid (Carr 1966: 30). Water evaporates slowly, which cools areas surrounding bodies of water. Water regulates the heat of Earth, making it very rarely extremely cold or hot. This allows humans to continue to exist, as we tend to survive much better in temperate climates than in very hot or very cold regions.

Water is a "remarkable solvent" (Carr 1966: 31). Inorganic compounds such as salt or phosphates dissolve in water, and make it very useful for watering plants because of the nutrients that it contains. Water is able to purify itself to a certain extent, too. Organic matter such as sewage that enters a sizable body of water is easily diluted. Eventually, the bacteria naturally present in the water will consume the foreign matter and, as long as oxygen supplies that plants produce hold out, will eventually rid the water of these human wastes (U.S. Dept of Health 1961: 8). I could go on telling interesting water stories to the reader because it is a fascinating substance that allows our existence in many ways. However, with a limited amount of space I must focus on other important topics. With this small bit of water lore, I hope I have given the reader a basic idea of why water is so important on a global level. Now I want to discuss some of the interactions humans have with water on a daily basis, from drinking it to swimming in it to bathing in it.

Of all the water that exists on the earth, only .009% of it is non-saline surface water and 1% of it is groundwater. This water is not spread evenly around the globe, either. The "bulk of the fresh water is concentrated in a few large lakes" (Speidel et al. 1988: 30) such as the Great Lakes in North America and Lake Baikal in Asia. What does this mean? Mostly it shows that in most regions of the world, the small amount of the total water supply that is available for our consumption is not abundant. According to Meybeck et al., humans only need a few liters of water each day to survive on, yet our demand for it encompasses much more (1989: ix). We use water for preparing food, for washing, for watering our plants, and much more. In more recent centuries, we have added many burdens to our usable water supplies, including the billions of gallons we use in industry, for recreation, and for getting rid of wastes we produce (U.S. Dept of Heath 1961: 3). What we use our budget of water for drastically exceeds our specific daily, bodily needs.

A renewable resource, the amount of water on earth at any given time is constant: it is neither increased nor diminished (Meybeck et. al. 1989: ix). Water cycles in what is called the hydrologic cycle. Water on the surface of the earth can follow one of three paths (Office of Technology 1988: 37). After falling in some form of precipitation, usually rain or snow, it can remain on the surface of the earth in the form of pools or snow. Evaporation of these sitting pools or transpiration as plants use the water at surface are both ways that the stored water reenters the hydrologic cycle. Water reaching the surface of the earth through precipitation can also become surface runoff in the forms of streams and lakes. This water will eventually be evaporated and start the cycle anew or will be infiltrated into the groundwater system. The last path that water may follow is that it may infiltrate directly into the ground and percolate into the groundwater system, where it will be stored for a certain period of time. Eventually, the water is reintroduced to the surface of the earth by slowly traveling through the ground until it reaches the ocean or by coming out of the ground in springs (Office of Technology 1988: 38). At the surface, the water will undergo evaporation or transpiration (known commonly as evapotranspiration) and the cycle begins once again.

With this short, simplified description of the hydrologic cycle, the reader can see that water is in continuous motion. It falls as precipitation and flows on the surface of the earth or into the groundwater or is stored in ice; no matter what, though, eventually it makes it back to a point where it is evaporated or transpired back into the atmosphere and can fall again as precipitation. In no part of this cycle is water "made" or "used up." Water is in different forms in various parts of the cycle, and may or may not be useful to humans depending on that form. No matter what, though, there is always the same amount. This amount, even though very little of the total quantity is freshwater, is plentiful enough to easily cover all of our current water needs (Meybeck et al. 1989: ix). But, as I pointed out before, this water is not equally distributed over the globe. Also, humans change this cycle by storing water for longer periods than it would naturally stay at the surface and by adding chemicals and other extraneous materials to the waters, making it less usable for humans. From such human influences and from the natural maldistribution of water on the globe, we now are facing two main water problems. First, water quantity issues exist, as there may not be enough water in a region to support burgeoning populations and industry. Second, poor water quality can diminish how much of the water in a region is suitable for our consumption. It is these two issues that I will focus on, as I believe it is these issues that must be addressed in order to solve our ever-worsening water woes.

There are periods of low or high rainfall in any area, both yearly and on longer time scales (Carr 1966: 92). Drought can be caused by a sudden lack of rainfall in an area where the population was used to a much larger amount. Most often there is some history of drought in such regions. Other times, though, an area that once had plenty of water suddenly finds it no longer has enough to cover all the water needs. Why is this? Most likely it is because there are more pressures on that resource from increased human populations and increased water consumption. Each home withdraws a certain amount of water from the local water supplies, and so less stays in the system. One river system or watershed that could at one point sustain all the towns within a region might suddenly not have enough water for a town far downstream because more of it is being used along the way. This is an example of a lack of water quantity.

Water quality is actually a set of guidelines as well as simply a general idea. Water always contains impurities because water is able to dissolve so many substances, as I have already discussed. However, when substances like sewage are dumped into water systems or when surface run-off picks up agriculture-based fertilizers and add it to local water supplies, the water quality becomes poore and so less useful to humans. I consider such substances as those I just mentioned to be pollutants, and I will refer to such human-based effluents as pollution from this point on. Water quality is a measure of how these impurities affect human health. The chemical and biological constituents in water have been measured, and guidelines have been established based on these measurements. The amount of certain microbiological indicator organisms in water is used to determine the hygienic suitability of water for drinking (Meybeck et al. 1989: 17). The amounts and the persistence of chemical substances, natural or otherwise, in the water are important to water quality. Put more simply, the amount of certain bacteria and certain chemicals affect water sources, and in high enough amounts, that water could cause the health of people depending on that water source to be negatively impacted. Water quality guidelines measure micropollutants, nutrients, acidity, and many other parts of water to see how they affect human health as we use the water in different ways (Meybeck et al. 1989: 20).

There are many substances in water to make it impure. Of these, some are helpful and some are harmful to humans. Some substances make the water unfit for human use because the quality of the water is so low (U.S. Dept of Health 1961: 6). In this way, water quantity and water quality are interrelated. Water may be available in sufficient quantity in a region but not with a high enough quality for people to use daily without becoming sick. Water can be cleaned to a certain extent of many micropollutants. In most countries, limits are set that dictate how "clean" water must be for various human uses. Different qualities of water can be used for different activities. Drinking water must be of a certain quality to be acceptable, while water for bathing might have a lower acceptable quality, and so forth. (Meybeck et al. 1989: 21).

Quality and quantity water issues are the basis for many of the water problems in the world today. It is also important to note how human-centered these problems are. I will not discuss how the effect of poor water quality or lack of quantity impacts the natural landscape or other organisms that live in an area. I will focus this discourse heavily on the effect of water issues on humans because I have found that it is often only when humans are adversely affected by a situation that major social movements get underway in an attempt to address a problem. In my experience, people do care about water and other similar issues and how these impact the natural environment before the issues begin to effect them personally. However, I have found that it is when a problem becomes an "I problem", a problem that affects people on a personal level, that many begin to actively advocate change. For this reason, I must leave the natural environment out of the picture, and focus solely on human-water interactions in this document. Before I begin to focus in on a specific case to illustrate water quantity and quality issues that impact human lives, I will provide an overview of some of the worldwide water problems that exist.

As the reader has already learned, problems that affect fresh water supplies are far reaching. Human alterations of the landscape and the introduction of more pollutants into waterways are some ways in which our water supplies are negatively impacted. How well a river basin catches water is influenced by the flora in the upper portions of the basin (United States Council of Environmental Quality 1988: 179). With a lesser amount of vegetation in this area, rain flows off slopes very quickly and, because there is nothing slowing it down, often has enough energy to take soil particles with it. Bigger floods occur and topsoils are carried downstream, decreasing biological production of lakes and the ocean that the water runs into by increasing the amount of silt in the water. Deforestation, burning and overgrazing all lead to this problem, and can be seen all over the world, including in Africa and the Himalayas (U.S. Council of Env. Quality 1988: 180).

Many major water problems are being caused by the increasing pollution of once-usable waters. Water is polluted when it "contains substances that make it unclean or unfit for our use" (U.S. Dept of Health 1961: 6). An increase of silt is just one way to pollute waters. A second form of pollution is the release of human wastes into water systems, including sanitary sewage and industrial discharge, also known as industrial effluent (U.S. Dept of Health 1961: 7). Sanitary sewage is everything we put down the drain and industrial effluents are all the different substances that are discharged from our factories. This urban and industrial effluent becomes concentrated in well-populated areas. These will continue to become bigger and bigger problems near the "world's largest urban-industrial agglomerations" and in developing countries where cities are unable to afford or unwilling to take on the cost of water treatment (U.S. Council of Env. Quality 1988: 184). In other words, big cities all over the world will begin to experience water quality problems if they are not already. These areas will also experience water quantity problems as they continue to grow because of the increase in "consumptive uses of water" (U.S. Council of Env. Quality 1988: 184).

Areas that are heavily impacted by water pollution from human wastes because of sewage often have many problems with disease. Without a good waste water disposal system, diseases are easily spread through waterways. There have been major problems with disease in Middle and Northern Africa in new reservoirs and irrigation systems, and such problems are common in many developing countries (U.S. Council of Env. Quality 1988: 187). Even areas with good sewage treatment risk giving the population cancer through the overuse of chlorine. Chlorine reacting with organic compounds in waste water forms a carcinogen (U.S. Council of Env. Quality 1988: 187), leading to health problems that we were trying to avoid by adding the chlorine in the first place.

Many water pollution problems result from modern agricultural practices. Fertilizer runoff is one such water pollutant. As we use fertilizer more and more to meet our increasing food needs as the population of the world grows, fertilizers will become even bigger problems. An increase in nitrogen in the water supplies causes eutrophication because the bacteria uses up all the oxygen in the water as it rabidly feeds off the extra nutrients (U.S. Council of Env. Quality 1988: 185). There is a similar occurrence when there is a glut of sewage in water. Pesticides are also causing problems in water supplies, and the use of these is increasing right along with fertilizer use. Pesticide pollution often kills fish even at only moderately high concentrations, and aquaculture in Latin America and Africa will eventually be threatened because of this (U.S Council of Env. Quality 1988: 186). Irrigation causes a large amount of salt to become concentrated in an area, and this salt can contaminate water supplies. Salt pollution will ultimately make "rivers unfit for for further irrigation" (U.S. Council of Env. Quality 1988: 186). This will drastically affect human life in many areas of the world, as irrigation is often the only thing that makes agriculture possible in a region.

Groundwater is another source of water for human consumption and use. It becomes more important as a source of water as surface fresh waters become polluted in the ways I have already outlined. Sadly, groundwater problems are becoming severe, also. These problems often occur for the same reasons that we are having problems with our surface waters. Groundwater, however, has some other interesting issues simply because it is water in the ground and not on the surface. Groundwater is water that has percolated into the soils and fills up the pore spaces between soil particles. These areas of groundwater are called aquifers. Water flows very slowly through the pore spaces of the ground and in some places stays underground for thousands of years. Island civilizations are especially affected if groundwater is polluted because this is often their only source of fresh water (Meybeck et al. 1989: 143).

Pollution caused by any of the sources that I have already mentioned drastically affects groundwater because it is not readily accessible and so very difficult to remove the pollutants. If pollution practices are suddenly halted in an area where a river or stream was impacted, the pollutants will eventually flow away and be diluted, and, on the whole, the waters are less polluted. Even bodies of water like pools and lakes are much more easily accessible than groundwater is. Pollution of groundwater could be a big problem and should be a source of concern for people who are aware of water issues. Luckily, groundwater is less likely to receive contaminated run-off waters than surface waters are (Meybeck et al. 1989: 65). Other problems exist for groundwater, though, and one of these is groundwater salinity.

Groundwater that has been in the ground for a very long time is often saline because it has flowed through mineral rich rocks or because of the sea being near-by. The saltiest water, though, tends to be underneath the younger, fresher water that has percolated in (Meybeck et al. 1989: 139) because the saline water is denser. Waterlogging an area and so raising the groundwater level can degrade soils because saline waters are in areas where they usually do not reach (Meybeck et al. 1989: 140), and this impacts plant growth. Other problems occur when too much groundwater is removed from an aquifer, and most of the fresh water is used up. The saline waters beneath the fresh water will begin to come up in a response to overpumping, and wells will have to be closed because such saline waters are not useful to us (Meybeck et al. 1989: 144). Mining and oil fields can also make groundwater more saline because of the release of salty waters created in these processes. The saline waters are of little use to humans and negatively impact an important potential water source.

For me, the most interesting thing that happens because of overuse of groundwater is the subsidence that occurs over an aquifer that is being overpumped. The main reason for this is because of what the aquifer is made up of. Such aquifers are made of sand or gravel, with high permeability (i.e. ability of water to flow through the pore spaces) and low compressibility interbedded with clayey layers (Poland 1988: 274). When an aquifer has more water taken out of it than is being recharged, or added back, the soil layers begin to compact . This starts to happen as the water pressure in the pore spaces decreases because the area is no longer fully saturated with water, and there is more stress on the soil particles. The land above the aquifer slowly sinks as the soil compacts. This type of subsidence is very slow, but the "ultimate unit compaction is large and chiefly permanent" (Poland 1988: 275). Obviously, such problems are exacerbated when a large city uses such huge amounts of water from an aquifer that natural recharge cannot replace all the water. The quantity problem gets worse as long as the city continues to grow. Even worse for the humans in such an area is that the city itself will be very adversely impacted because of the subsidence. Areas throughout parts of the United States, in Mexico, in Guatemala, and all over the world are affected by this problem.

In areas like Oklahoma, Kansas, Nebraska and Texas in the United States, aquifers are relied upon for irrigation purposes (Postel 1988: 308). Now people are beginning to realize that this series of aquifers has been unable to recharge to its previous level. If irrigation is continued at the same rates, in the future there will be no possibility of farming in these areas at all. If the irrigation is not slowed, food resources that future generations may depend upon for survival will no longer be available, and future populations could go hungry. This problem of over-pumping occurs all over the world; areas of India, China, and Mexico all have problems from over-pumping their respective groundwater supplies (Postel 1988: 309). Overuse causes problems with lakes and streams, too. With increased pressure from humans on them, lakes and rivers will shrink. The death of some lakes, such as the Aral Sea in Eastern Asia, will continue if the pressure on the lakes is not somehow relieved (Postel 1988: 310).

Obviously, something needs to be done about these problems. Many of the problems are exacerbated because of poor management of the available resource. Control measures need to be taken to ensure that we are not making the problem worse and are actually working towards solving the problem. According to Meybeck et al., strong action on national and international levels has helped to make sure that some of the major pollutants are being strictly regulated (1989: 279). However, the problems are far from being resolved. Although many industrial countries now require specific standards for waste waters, much of the Third World does not. Developing countries, especially, have very few, if any, regulations (Postel 1988: 307). In contrast to this, industrialized countries, mostly in Europe and North America, experienced the pollution problems that I have discussed and have reacted to them by making sewage disposal regulations, banning hazardous pesticides (DDT) and industrial chemicals (PCBs), putting in wastewater treatment centers, and treating industrial effluent (Postel 1988: 293). I wish I could say that these have solved the water problems in these areas. They do help relieve some of the worst problems, but other problems spring up. For example, polluted water from a country without regulations in place can easily cross political borders into nations that have regulations but are downstream. Remember, water is not held by borders and we all must share the limited supplies.

While many countries are attempting to address water quality problems, the problem of water overuse has yet to be solved in any location. One way to attempt to solve this problem is through conservation. However, if water is extremely inexpensive for industry and for everyday use, no one thinks to conserve it. One way to try to solve the problem of overuse is to make the price of water actually reflect the cost of the water, both environmentally and economically. If the use of the water will eventually mean that no water will exist in that area, the price should reflect how dear that water is to the present and future populations. According to Rogers, reasonable pricing of water could have "powerful ramifications" for slowing the overuse of water (1988: 381). Unless a person's water bill reflects the need to conserve water, especially in areas that must artificially recharge or augment the natural water amounts in the area because of overuse, she will not feel any reason to use less water (Postel 1988: 315). The same is true for industry, which also consume large amounts of water and should pay for that use.

True water costs could have large impacts on the overuse of the resource. Other avenues could be taken, also, to try to address this issue. One such avenue is to simply become more efficient and to use improved technology to stop water waste (Postel 1988: 315). Leaks and seepage add to the amount of water used in a situation above and beyond the amount that is actually needed. However, using new technologies also adds costs to water use, and one must remember this when talking about how simple it would be to change systems of irrigation or to revamp a water system (Postel 1988: 317). The cost is there and real, and it is not so simple to begin using new technologies when there is no money available to take care of these costs. All the issues I have mentioned here will become more important later in my thesis, but I wanted to make sure that the reader was starting to think about the different ways we can try to solve water problems before I moved on.

I have taken the reader on a very quick trip through the water cycle, water issues that the world faces, and some ways to solve those problems because I wanted to make sure that he realized that this is a global issue. Everything I have discussed impacts more than one area of the world. I also needed the subject of this chapter to prepare the reader for the rest of this document, as I begin to talk about an area that has many of the water problems that I have introduced. In the next few chapters I will be focusing on the Mexico City Metropolitan Area as a case study for water issues. I will discuss what issues are there and what is being done to deal with them. Now that the reader is at ease with water topics and before I focus entirely on such a small piece of the world, I am going to briefly discuss Mexico as a whole so that she can understand what that country faces with water issues and how these issues relate to population, climate, geography, and much more.

CHAPTER TWO

The Nation of Mexico

Mexico, which is the third largest of all Latin American countries in area, is divided into 32 political subdivisions called states, just like we have here. These states abound in different natural resources, from land to minerals to petroleum (Mexico Banco Nacional 1960: 71) and, of course, water. I will be spending the next few paragraphs discussing Mexico in general so that the reader will have a good understanding of this country as I begin to focus on it more. To understand the environmental problems that exist for the people in Mexico, one must first understand the landscape and how resources are distributed. Land is abundant, and has been cultivated more and more as irrigation projects have been taken on by the government (Banco Nacional 1961: 72). Fishing, forest resources, and minerals are other economically beneficial resources that Mexico has and uses. As I am focusing on water as a resource, the others must only be mentioned in passing and left at that.

Geographically, Mexico sits between the Atlantic and Pacific Oceans at the southern edge of North America (see Figure 1). The country is bounded by the United States to the North and Guatemala and Belize to the south (Banco

Nacional 1960: 16). Mexico has been described as being shaped like a "horn of plenty" (Banco Nacional 1960: 16) because it consists of a "great triangular-shaped area" and forms the tapering end of the North American continent (Enock 1909: 135). At the point of greatest length Mexico is nearly 3000 kilometers long and at the point of greatest width it is 1266 kilometers wide (Enock 1909: 135). It is almost nine times as large as Great Britain, and encompasses deserts, tropical forests, beaches, and almost any other environment a person can imagine. In my own limited travels through Mexico, I found that a person could drive through miles and miles of densely populated areas and then suddenly find herself in the middle of steamy mountain zones, where the narrow roads were surrounded by large expanses of seemingly unpopulated forests and fields.

A good portion of Mexico is in very high elevations (see Fig. 2). Mexico is characterized as a plateau country, with 40 percent of its lands lying above 1300 meters in elevation that is contained within the northern and central plateaus (Cummings 1972: 2). The Eastern and Western Sierra Madres, the mountain ranges which surround the big central plateau that makes up the majority of the country, merge and become one right around the Valley of Mexico. This valley encompasses Mexico City and its surrounding areas (Enock 1909: 136). The land ends up having a sloping plateau effect: it is highest near the Valley of Mexico at 2500 meters above sea level and slowly slopes down through the country and is at approximately 1300 meters elevation as it reaches the border to the United States. With the coastal regions being at sea-level, of course, these elevations are really quite dramatic.

The Sierra Madres are the Mexican Andes, though the majority of the basins formed between peaks have since been filled with volcanic discharge and eroded material from the mountains (Enock 1909: 137). Generally what is left are reasonably large basins, such as the Valley of Mexico, with the tops of mountains sticking up betwixt them. This mountainous region is the main orographic region in Mexico. This region will be important because it is here where the Valley of Mexico and the MCMA are located. The other important orographic region is the immense plains of theYucatan, which have a comparatively low elevation of no more than 100 meters above sea level. Once again, the reader can see how dramatically different these large regions are in elevation, which leads to varying climates and resource availability.

The climate in Mexico is as varied and dramatic as its elevations (see Fig. 3). The Tropic of Cancer crosses through the center of the country, and so Mexico is in the semi-tropical part of the world. I had always pictured Mexico as being rather hot, as it is so near the equator. And many places there are very hot. However, the varying elevations make zones of both temperate and even cold climates (Enock 1909: 146). The tropical lowlands can be quite oppressive and the humidity can debilitate an unwary traveler quickly. In upper elevations, the hot summer days lead to cold summer nights because of the altitude. Mid-elevations tend to be very temperate. The variability in climate is reflected in how water sources and precipitation quantities are distributed around the country.

As the reader probably suspects, the water resources in Mexico are not regularly distributed across the country. Rivers tend to to be torrential in character because of the mountainous terrain, which does not make them very navigable or useful as harbors (Enock 1906: 144). However, these quickly

Figure 1: The Nation of Mexico

(Simon 1997)

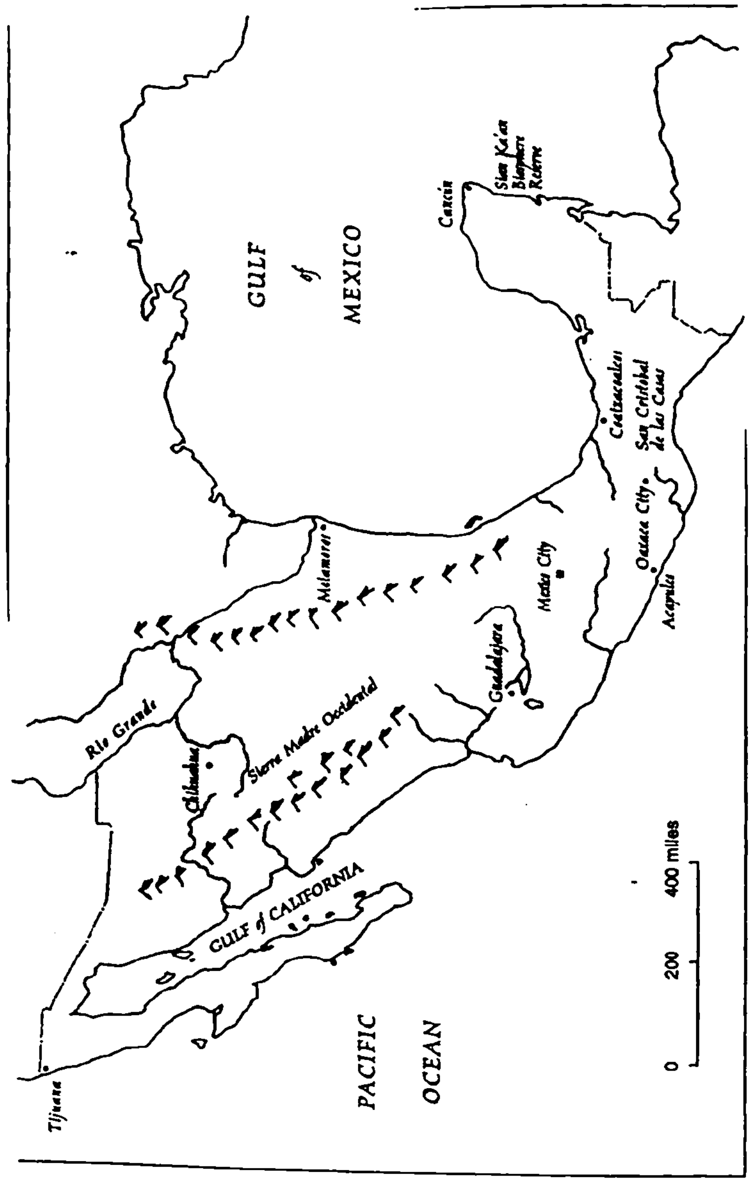
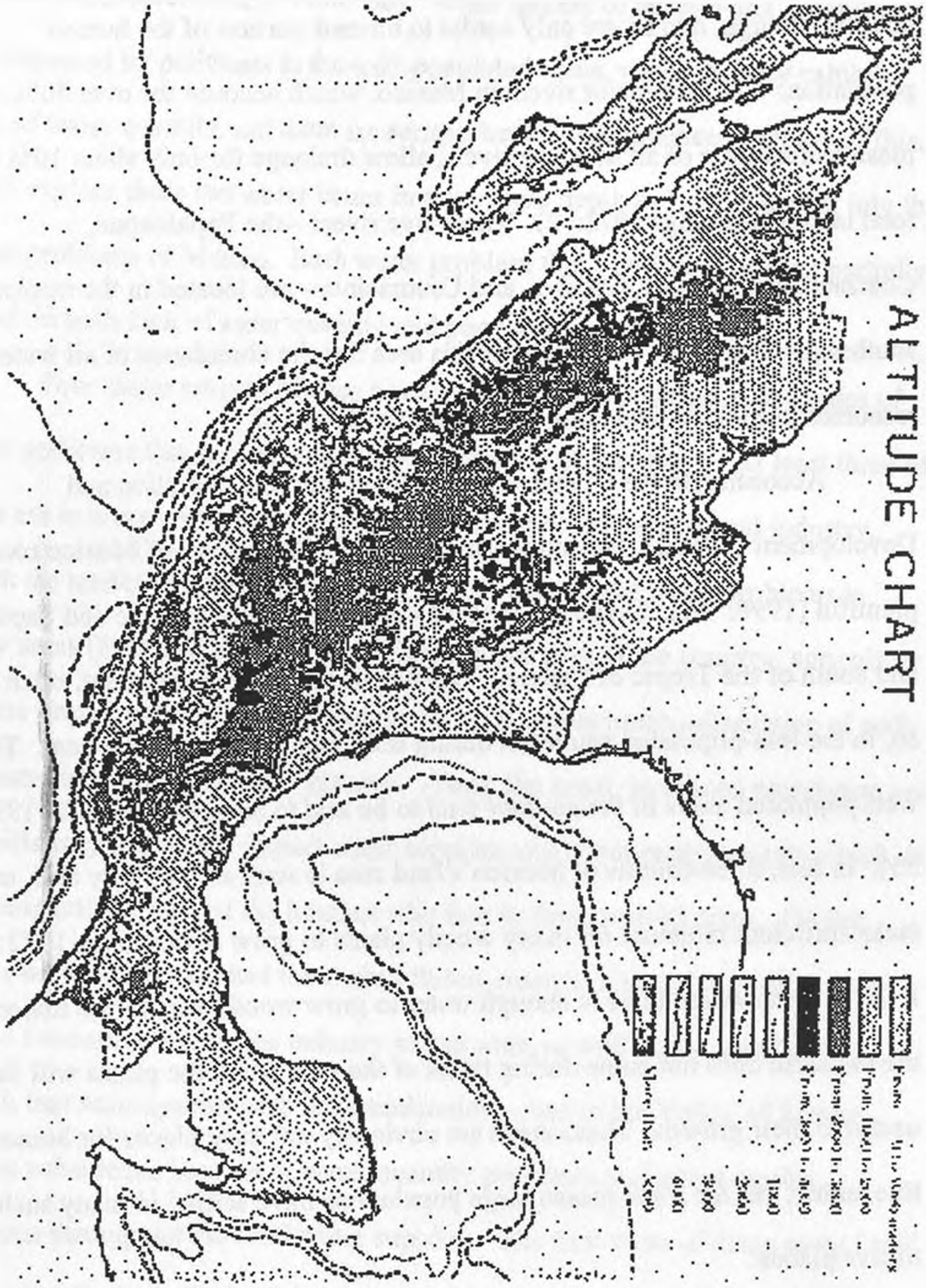


Figure 2: Altitude Map for Mexico

(Banco Nacional 1960: 70)



flowing waterways are very useful for electric power (Banco Nacional 1960: 72) and can also be used for irrigation. These rivers are maldistributed across the country, though, and so are only useful to a small portion of the human population. The five major rivers in Mexico, which account for over 50% of the mean annual flow of all Mexican rivers, allow drainage for only about 10% of the total land (Cummings 1972: 2). These five rivers --the Papaloapan, Coatzacoalcos, Tonalá, Grijalva, and Usumacinta-- are located in the tropical southeast. This is not surprising, as this area has the abundance of all water resources in Mexico, including an abundance of rainfall.

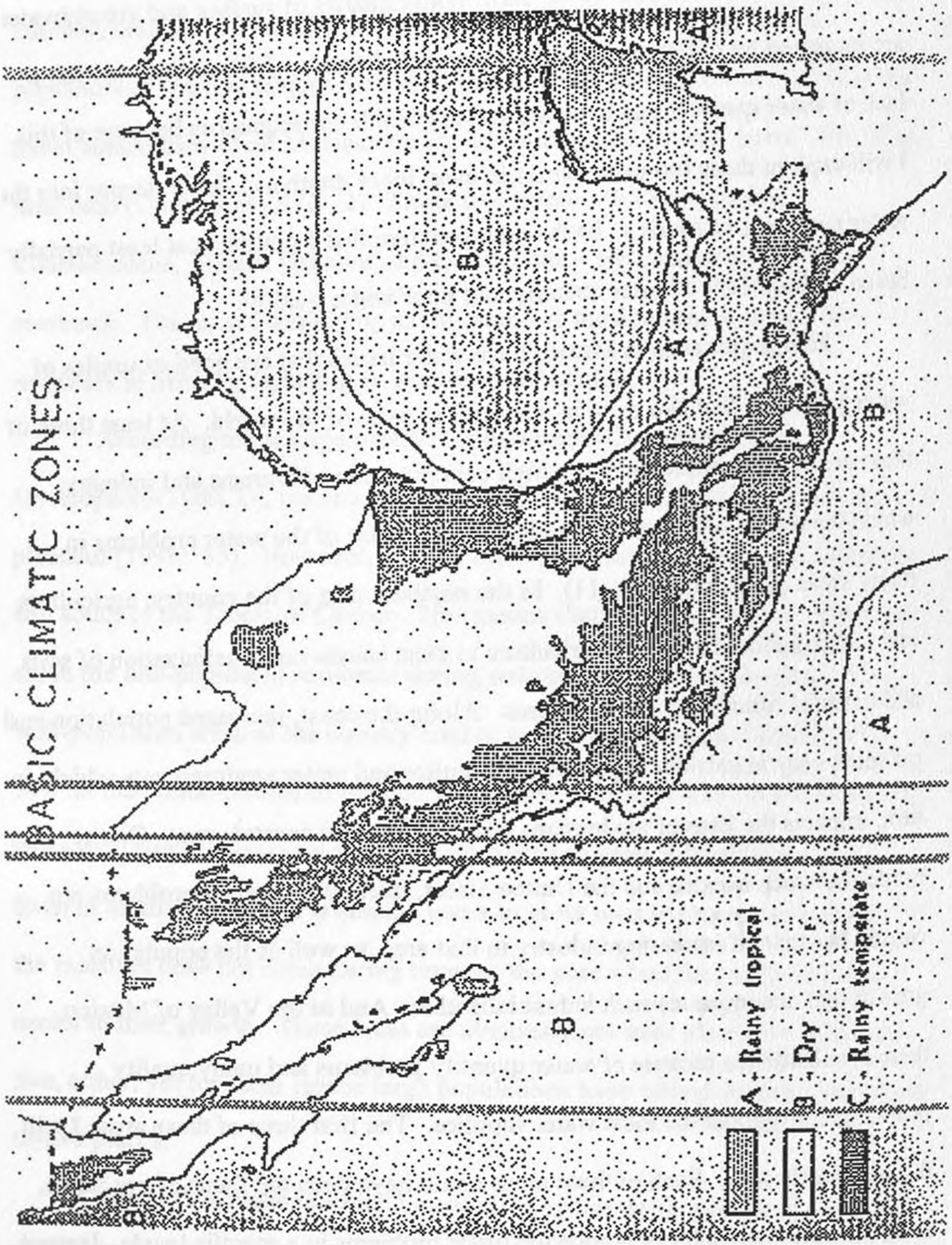
According to the Organisation for Economic Co-operation and Development (OECD), the amount of rainfall that the nation of Mexico receives is plentiful (1998: 55). However, most of this occurs between June and September and south of the Tropic of Cancer. This means that rain is abundant, often overly so, in the less-populated southeast during only certain times of the year. The well-populated areas of the country tend to be arid to semi-arid (OECD 1998: 55). In fact, three-fourths of Mexico's land area is semi-arid to very arid, and so lacks sufficient moisture for many woody plants to grow (Cummings 1972: 1). Even in areas where there is enough water to grow woody plants, the majority of the moisture does not come during times of the year when the plants will find it useful to their growth. These areas are obviously not easy places for humans to live, either, yet for some reason large populations have settled in many such hard-to-live places.

The high elevations which I mentioned earlier throw another interesting twist into the problem of availability of water in the country as a whole. Three-fourths of the population of Mexico lives above 500 meters, and 80 percent of Mexico's industry is located there, as well. However, most of the water resources lie below that level (OECD 1998: 58). Water quality of surface and groundwater are impacted by pollutants in the well-populated areas, which already exhibit a lack of water quantity, and there are serious health consequences because of this. I will explore these two water issues in even more depth as I delve deeper into the water problems of Mexico. Each water problem that I outline is at least partially based on both lack of water quantity and poor water quality.

Four major areas in Mexico have water issues that are good examples of water problems that also exist in many other parts of the world. At least three of these are in areas where there is a high concentration of humans and industry, which the reader will soon learn to be a major cause of the water problems in many areas (Restrepo 1995: 11). In the northern part of the country, agriculture and the irrigation that allows agriculture to exist causes much salinization of soils and harmful runoff into water systems. Along the coast, increased population and oil spills very negatively impact water supplies and water environments which, in turn, impacts the lives of the humans who live in these coastal areas. On the border between Mexico and the United States, many major water problems are caused because of increasing industry in that area, as well as the population growth that accompanies such industrialization. And in the Valley of Mexico, there is subsidence because of water quantity problems and many quality problems throughout the local water supplies. The first three of these areas I will discuss briefly here. Each of these areas could have been the focus of my thesis, as all are good examples of worldwide water problems in a specific locale. Instead,

Figure 3: Climate Map of Mexico

(Banco Nacional 1960: 76)



though, I chose the Valley of Mexico and the Mexico City Metropolitan Area that lies within it as my case-study, and the other three water problem areas can only be briefly outlined.

A good part of Mexico's arid north's water woes are caused by the fact that the supplies of water that exist are not readily available to areas with a high water demand (Cummings 1972: 4). Reservoirs in distant mountains or mountain runoff are generally the ways used to combat the lack of rain, and such supplies are used for irrigating the crops. The traditional problem with agriculture in many areas of Mexico has been the water shortage that exists in regions that could otherwise base its economy on agriculture (Banco Nacional 1960: 108). Irrigated agriculture is up to 2.5 times more productive than dry land agriculture, so it is obvious that this would be the agricultural type of choice by the population in any more arid region (OECD 1998: 59). With irrigation being used to allow agriculture in an area, more people now depend on water for agriculture and their survival. Less water is available for local populations to use on a daily basis because it is needed to keep the national agricultural production high (OECD 1998: 59).

Today, three-tenths of Mexico's crop land is irrigated, making it one of the world's largest irrigation countries in terms of surface area. Only 40 percent of the water used for irrigation actually reaches the crops (OECD 1998: 59) and not all of that is even needed. The usual irrigation methods used in Mexico involve gravity-based irrigation, using either the channeling of water through parallel furrows or the flooding of entire fields (United Nations 1990: 154), inundating the fields with little or no control. The extra water that is not needed for the crops is called the return flow, and can be as much as one-third of the original flow. This water contains varying amounts of suspended solids, dissolved salts, fertilizers, and pesticides (United Nations 1990: 154). As the reader will remember from the first chapter, the dissolved salts lead to increasing salinity of water, and eventually becomes so saline that it is no longer useful for agriculture, which exacerbates the lack of water quantity that already exists. The other substances lower water quality in a water system.

Over the years, the amount of area in Mexico that uses irrigation has steadily increased. These areas tend to also use more fertilizers and insecticides (Banco Nacional 1960: 108), which adds to the negative effects that agriculture has on water supplies. Pesticides and fertilizers are being used steadily more in Mexican agriculture. With continued use, pests become resistant to pesticides and soils get depleted and need even more fertilizer in order to grow a decent crop. The soils become unable to continue to support crops. In a nasty positive feedback loop, more pesticides and fertilizers are needed to just obtain an adequate crop from soil that did not need the additives at one time, and the problem grows steadily worse. Mexico has had largely unrestricted pesticide use for many years, and farms use them in ways that make them serious health risks to local populations, especially for the people who work with the pesticides.

Pesticides, insecticides and herbicides usually can be characterized by two major factors (United Nations 1990: 155). One, they are toxic to humans and aquatic life. The water problems abounding from that have obvious consequences as the pesticides run-off into the local supplies. Pesticides and other like substances cause serious health problems in people who drink the water, or even wash dishes and/or themselves in it (Nuccio et al. 1990: 34). The second major problem with pesticides is that they tend to degrade very slowly, if at all, and so tend to accumulate in systems and are even more harmful. They also become concentrated in food chains (United Nations 1990: 155). An abundance of fertilizer runoff can also cause health problems. It makes a water system less useful because the abundance of nutrients from the fertilizers causes eutrophication to occur. In such cases, organisms such as bacteria living in the water cannot survive without a good supply of oxygen, and so added fertilizers can no longer be broken down by these organisms (United Nations 1990: 155). These problems are the same as I mentioned in the first chapter as world-wide problems, and they are obviously evident and thriving in Mexico.

Pastoralism, which is related to agriculture in many ways, involves the grazing of animals on land. This grazing is mainly done by sheep in Mexico. I bring this up because I find it an interesting note in the whole discussion of agriculture and agriculture-related water problems. When even a few sheep graze an area, the environment begins to degrade. Sheep graze the ground cover close, leaving little of a plant left other than the roots. This means that soil particles come loose easier, there are less plants to stop floods, and nutrient-rich soil is blown away (Melville 1994: 114). Ironically, having sheep graze in an area such as the Valle de Mezquital that was once noted for its agricultural prowess ruined the locale for crops. The crops were watered from a local spring, and having the sheep grazing in the recharge area of that spring removed ground cover and made it more likely that the water would flow off and so less percolated down to recharge the local aquifer (Melville 1994: 109). Agriculture is effected badly by grazing, and more irrigation is needed to keep the crops alive. All the agricultural based water problems that I discussed above become even bigger problems because of this kind of grazing.

Agriculture is only one of the major causes of water problems in Mexico. The water in the coastal zones are under many of the same pollution pressures as the irrigated agriculture areas of northern Mexico. These problems, however, are caused more by an increasing tourist trade leading to an increasing amount of human-based pollutants entering the waterways. While much of the impact is on the natural environments and ecosystems that exist within this area, human life is also impacted, and so I felt obligated to mention this water problem as well as the others.

Much of the time, the water in the hydrologic cycle ends up in the ocean before getting evaporated and reentering the cycle. This means that pollutants that are added to rivers and streams all over the country could eventually end up in the coastal waters. Natural pollutants, such as nitrogen or phosphorus, can be problematic (Botello et al. 1995: 57), but it is the artificial pollutants that are the most destructive and dangerous. The effect of PEMEX, Mexico's major oil company, on the environment in general and on water in Mexico is a good example of artificial pollutants. The pollution of the oceans by fossil fuels is a major problem (Botello et al. 1995: 57). This company releases many effluents into the ocean from the off-shore drilling that it does. In addition to this one company's discharge, effluents enter the ocean because of waste waters being released from urban and industrial centers and from ships, pesticide and fertilizer runoff, and oil pollutants from oil extraction. All these eventually run into the sea. Though the ocean is immense and can dilute many of the pollutants so they are not too harmful, the amount being released into seas is so huge that the rich coastal ecosystems are being very negatively affected (Nuccio et al. 1990: 26).

As these poisons enter ecosystems in higher and higher amounts, they also begin to show up in human populations. Humans are generally at the top of the food chain and eat other high food-chain organisms. Heavy metals, fossil fuels and substances like DDT all accumulate in organisms that live and eat in the coastal areas. Higher levels of these pollutants are found in organisms higher up on the food chain, magnifying the problem (Botello et al. 1995: 57). When humans eat sea creatures like fish they get heavy doses of the poisons, which can cause cancer and birth defects in offspring. The high quantity of human-introduced pollutants is negatively impacting the natural environment and this leads to problems for the humans that live in this same area.

The tourist trade in these areas is impacting the health of the coastal waters negatively, too, and I find this very interesting. Much of the coast of Mexico is intensely beautiful, with white sands and warm, aqua waters that appeal to many tourists. Cancún and Acapulco are household words in the United States, and are used as examples of warm, sunny places that we would all like to visit during our own dreary winters. Having visited the coastal town of Xijuatanejo, I can see why so many people want to go there to visit if given the chance. The tourist trade in many such areas started as few as thirty years ago, when bankers began to realize the money-making potential tourism could have (Simon 1997: 180). At first, there were many attempts to keep the environment from being obviously polluted because it was important to keep the area clean in order to attract tourists. However, it appears that no one had any qualms about changing the natural landscape by enlarging beaches and destroying wetlands to make the area more attractive to tourists. The activities of humans in previous times did not cause perceptible harm to these ecosystems. This all changed with the intensification of industrial and commercial operations along the Mexican coastline as tourism increased (Botello et al. 1995: 55).

People quickly realized that large amounts of money could be made in these areas, and the people who were already making money wanted to continue to do so. Because of this competition, cheaper package deals were offered and more tourists were able to come to these once-pristine beaches (Simon 1997: 182). More tourists and more development meant more jobs, and so the year-round populations of these areas grew, also. Not surprisingly, this has led to increased pollution problems. While tourists move on to other towns as many of the natural sights become too polluted to enjoy, the problems remain. In my visit to the Mexican coast, I found that the year-round dwellers of these areas usually do not swim in the cleaner, tourist areas. Instead, they swim in areas where the waters are not of a high enough quality to be safe. The poor quality of water in these areas was greatly exacerbated by the growth of the human population and the increased tourist trade, and it is the local populations who bear the brunt of these problems.

The biggest and probably the most well-known Mexican water problem that I am going to discuss in this chapter is the problem along the border between Mexico and the United States. The passing of the North American Free Trade Agreement (NAFTA) and discussions of the positive and negative effects that

NAFTA might have has made it so many people in the United States have some inkling of the problems in this region. Throughout the debate over NAFTA and its pitfalls in the early 90s, articles were written and studies done on the lives of the people and the conditions of the resources in the border towns. The main problem in these towns is based on water quality issues with, not surprisingly, a related water quantity problem. Severe dumping by industry along the border has made the waters squalid and extremely dangerous to the people who must live near the waters.

Foreign-owned assembly plants, or maquiladoras, began to appear in the border towns such as Tijuana in 1965 when Mexico invited them in as a way to create jobs and improve the Mexican economy (Simon 1997: 207). However, this did not have the desired effect. The devaluation of the peso in the early 80s made Mexico an even better place for the maquiladoras, because labor was so cheap. Many of the border towns are squatter settlements, where the maquiladora workers live (Simon 1997: 206). Even though the going wage is only about five dollars a day, this is much better than most of these people can do elsewhere in Mexico. Thousands of people live in the hills around the areas of high industry, many "without water, sewage service, or electricity" (Simon 1997: 206). Their wastes enter the local waters, as there is nothing else to do with it and no treatment plants available. This, however, is not what causes the biggest water problem, though these are the people who are most affected by it.

Many people are concerned that one of the reasons that industry from the United States was so eager to move to Mexico with its assembly plants was because the pollution controls there were less strict than in the United States

(Nuccio et al. 1990: 38). The industries, many of them electronic in nature, require "the storage, use, and disposal of a wide range of hazardous materials" (Nuccio et al. 1990: 38). Whatever the factories put down the drain enters the waterways and becomes a problem for the people living in those waters. Simon mentions that many extremely toxic wastes were dumped down the drains along with normal waste water, which were already potentially hazardous for the populations living around the waterways (1997: 208). NAFTA was supposed to increase the pollution control requirements and create more jobs in the Mexican economy. However, even before NAFTA, there were laws and treaties that were supposed to insist upon proper disposal of wastes (Simon 1997: 209). I have never been to the border areas, but from what I have read and how I heard the Mexican people react to the mention of NAFTA when I was visiting that country, it seems that little has changed and pollution problems still abound.

The industrial effluents and toxic waste present in the waterways cause severe health problems for the people who are dependent on them. Many illnesses are caused by contaminated water, and such contaminated waters are one of the major causes of illness on a global scale (Juan et al. 1995: 20-21). Studies of water contamination have indicated that pregnant women may be especially susceptible to the health effects of solvents and chemicals used in industry (Nuccio et al. 1990: 38). Most of the people who work in these areas must work with dangerous chemicals and solvents on a daily basis. What makes it even worse, though, is that the chemicals are subsequently released into the waters that these same people must use to survive. There is concern on both sides of the border because little is known about the exact kinds, quantities or disposal of these wastes (Crane 1997: 51). The effects of these pollutants on the population, though, are known to some extent. According to a 1990 government study, 16.4 percent of the population in these areas had some sort of skin disease, most likely related to the chemicals released by the industries (Simon 1997: 209). People have infections, boils, and diarrhea. In 1990, also, levels of lead in creek waters near the factories were 3400 percent higher than the U.S. federal standard (Simon 1997: 209). This pollution level is high enough to kill people, not just make them unhealthy, and people do die from what seem to be diseases from the poor quality of local waters.

As with all the areas I have introduced the reader to so far, a water quantity problem also exists in the border region. The industries have supplied jobs for many people who are trying to find some way to survive. People have moved into the squatter towns, even with the lack of electricity and running water, because it is close to places where they can find jobs. This exacerbates the problem of insufficient water supply that already exists along the border (Crane 1997: 52). The water supply is severely limited in many of the major border cities because of the local climate. A minimum of rainfall ensures that little water is in this area, and as people pour in to find jobs in the industries which also use large amounts of water, this limited supply is taxed even more. The rapid urbanization not only causes water quality problems, but makes it so even less of the burgeoning population has an adequate amount of drinking water (Crane 1997: 49).

These water problems along the border, severe for the Mexican people who live in the area, are very good examples of how water problems transcend political boundaries. These problems do not stop at the border between Mexico and the United States. The Tijuana River carries the wastes across the border and through farmers' fields in the United States before emptying into the Pacific Ocean (Simon 1997: 211). Dumping from factories in Nogales, Mexico has contributed to groundwater pollution both in Mexico and Arizona (Simon 1997: 212). According to Simon, "more than 100 million gallons of Mexican raw sewage is dumped into border rivers that flow into the United States" (1997: 212) each year. On an even bigger scale, all the sewage that reaches the ocean and adds to the amount of unwanted substances there transcends all political boundaries, as the seas are interconnected and surround the globe. These water problems are not just Mexican, neither in origin nor effect.

The water issues that I have outlined here are all related to how the water resources are available in Mexico, as well as how the people are using the resources. I could not go into great detail on each of these problems, though all of are great interest and relate to the global water problems. Each of these water issues are important and the reader should be aware of them all, as all are fascinating and affect more than just the people of Mexico. However, I have chosen to focus on the water problems of the Mexico City Metropolitan Area located within the Valley of Mexico as my case-study. I will spend the next few chapters focusing on the water problems that exist there and the reasons for them, based on the geography and history of this area. I will also discuss the response of the Mexican government to these problems, both on a national and city level, so the reader can understand not only the problems, but some possible solutions.

CHAPTER THREE

The Mexico City Metropolitan Area

The Valley of Mexico, within which Mexico City lies, is located in the Basin of Mexico in the central part of the great plateau (see Fig. 4). The basin has an approximate area of 9000 square kilometers and is the highest valley in the region at an altitude of 2200 meters above sea level (Joint Academies Committee 1995: 8) The Valley of Mexico is partially divided from the rest of the Basin by several low mountains (Joint Academies 1995: 9). Like the rest of the Basin of Mexico, water has always been a problem in this interior drainage basin. According to Monteverde, this closed basin, in which no water naturally flows out to the sea and none flows in, has had either too much or too little water throughout its history (1991: 49). I will give the reader a brief historic outline of this area so that she will be able to see how the water issues have affected the people of this area.

The area within the Valley of Mexico has an annual rainfall of 700 mm, though most of it falls in a few severe storms between June and September and the area is basically dry throughout the rest of the year (Joint Academies 1995: 8). The intense rainy seasons that occur in this area can cause large floods. At one point, the flooding lasted so long that a series of lakes formed within this basin (Joint Academies 1995: 9). During seasons of drought, some of the lake water would evaporate. Much of it, though, would percolate into the soil to replenish the large aquifer, known as the Mexico City Aquifer, that formed within the rock units below the ground surface in the basin (Monteverde 1991: 49). Some of this water was disgorged by many springs along the lakeshore. These springs provided fresh water for consumption, as most of the lakes were saline (Simon 1997: 65). During heavy rains, flooding was prevalent, while dry seasons caused the springs to dry up. Because of these environmental conditions, any civilization that has lived in this area has had to face the struggle between getting enough water water to drink but not having too much water to comfortably live.

The Aztec, one of the indigenous civilizations who lived in the valley for centuries before the Spanish arrived, survived this struggle surprisingly well. Theirs was a struggle to control their water environment and to survive in an area where no water flowed in or out of their relatively small valley (Simon 1997: 63). When the Spanish arrived in the Valley of Mexico, they found what they described as an astoundingly beautiful Aztec capital city called Tenochtitlán (Diáz 1956: 190). The city was actually built on the six shallow, interconnected lakes that existed at the time (see Fig. 5). These lakes were Zumpango, Mexico, Ecatepec, Texcoco, Xochimilco, and Chalco, with only the lakes Xochimilco, Mexico and Chalco containing fresh water (Anton 1993: 113). Gardens, flowers, and trees abounded as a tribute to the water god Talco who the Aztec believed provided the sacred liquid, and the island city was magnificent to behold (Simon 1997: 63).

Though the Aztec seemingly embraced water and felt safe living surrounded by it, they did not live in that way very easily. The city was frequently inundated by flood waters because of the very slight difference between the level of Lake Texcoco and the level of the city (Diáz 1956: 198). Three causeways were built between lakes in the 1400s in order to separate the fresh and brackish waters of the different lakes, and to help control the floods (Anton 1993: 116). Unfortunately, these causeways were not enough to handle the huge amount of water that would enter the city, and the city was almost destroyed by huge floods between 1440 and 1450 (Díaz 1956: 198). In 1449, huge dikes were built, and over the next decades more dikes were erected, causeways expanded and canals dug crisscrossing the city in an effort by the Aztec to control the waters that threatened the existence of the city of Tenochtitlán (Simon 1997: 63).

Not surprisingly, based on the climate and hydrology of the valley, the Aztec also had a problem in finding enough water to support the population of their capital city. Near-by springs provided some water that was collected as it came to the surface (Simon 1997: 63). This relatively small amount of water, though, could not sustain the burgeoning population. A series of military campaigns were begun to gain control of the water supply in the valley, and by the mid-fifteenth century the Aztec had the control of the fresh water supplies (Simon 1997: 63). A large aqueduct was built to bring water to the city and sustain the population, and water quantity problems were held off for the time being.

The Valley had a population conservatively estimated to have been

Figure 4: Location of the MCMA

(Joint Academies 1995: 5)

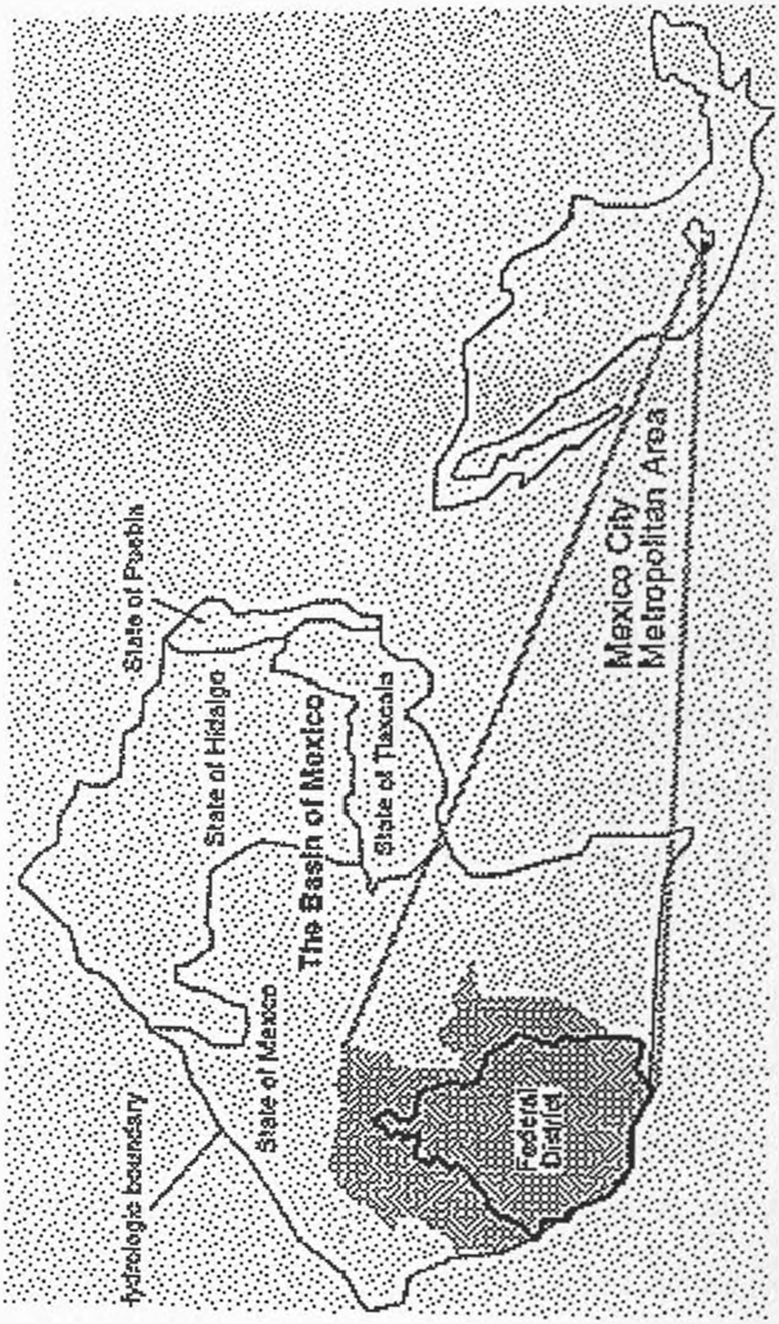
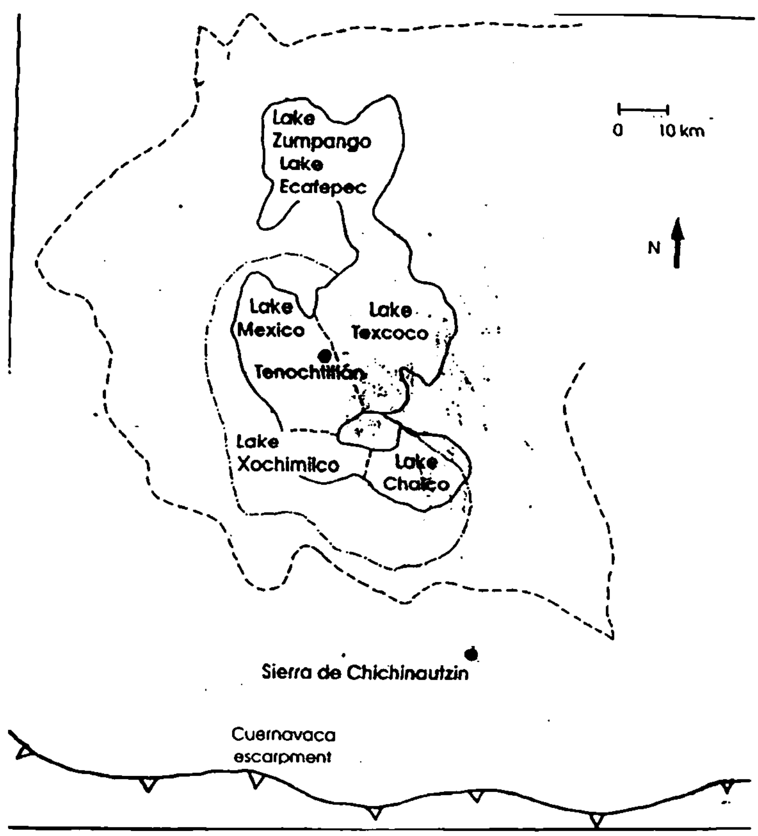


Figure 5: The Ancient Lakes of the Valley of Mexico

(Anton 1993: 115)



between one and three million in the early sixteenth century, as the Spanish were arriving in Mexico (Gibson 1964: 5). Water was being imported on aqueducts, and excess water was being stopped by dikes and causeways. Bernal Diáz talks about the amazing cleanliness that existed in a city of so many people (1956: 202). The Aztec had strictly forbidden garbage or human waste to be dumped into the lakes because of the effect it would have had on their food supply (Simon 1997: 65). Even so, Gibson brings up the distinct possibility that the Aztec were using all the available resources at the time of the Spanish arrival (1964: 5). This careful cleanliness was important to ensure the continued existence of the Aztec civilization. The advent of the Spanish into the area, and their eventual conquest of Tenochtitlán, drastically changed the way these already pressed resources were used and how the Valley system worked as a whole.

After a two year campaign against the Aztec, the Spanish, led by Hernán Cortés, managed to conquer the city of Tenochtitlán. However, by that time the once-beautiful city that Cortés had admired for its aesthetic appeal was a pile of rubble, with the hydraulic infrastructure in ruins (Simon 1997: 64). A decision was made to rebuild the city, this one to be a Spanish capital, on the very same site. This was Cortés's idea, and it prevailed over the "contrary majority opinion of his followers" (Gibson 1964: 368). This decision meant that the city would always be exposed to flood, would face problems of lack of water quantity, and that the environment around it would be a swamp land (Gibson 1964: 368). Obviously, this area was hardly an ideal site for a Spanish city, especially because, as Simon points out, the Spanish were a very land-based people who were not used to living in watery environments (1997: 64). Cortés's insistence upon rebuilding on the site of the former Aztec capital instead of on the lake shore will be one important component behind the problems that the people living in this area face every day. I will outline these modern water problems shortly, and we can already see the beginnings of them in the early history of the Spanish civilization in this area.

The "equilibrium of resources and population changed abruptly" after the Spanish conquest (Gibson 1964: 5). More trees being cut down increased the amount of soil erosion during heavy rainfalls and the heavy grazing by the sheep and cattle that the Spanish introduced exposed even more hillsides to heavy erosion (Gibson 1964: 5). As the reader knows from earlier chapters, such circumstances not only remove important topsoil that could otherwise be used for agriculture, but also cause an increase in flooding. Flooding had already been a problem in the Valley, and the Aztec system of control with dikes and causeways had been ruined during the war. Also, the lakes, which had formerly been reasonably clean, were soon little more than garbage dumps for the Spaniards (Simon 1997: 65). The Valley was changing, and, in my mind, it was not changing for the better.

Only forty years after Mexico City was founded, floods that were once only periodic became perennial (Simon 1997: 65), and a good portion of the city was under water most of the time. People had to move to dryer land and make do with using canoes for the majority of their transportation. These problems did not abate as the years passed, even when what is known as the Desagüe General or General Drain was dug (Gibson 1964: 6) to relieve the pressure, and the struggle to control the inundation of water into the city lasted for more than a century. I wanted to outline this short historical view of the Valley of Mexico so that the reader understands what the natural environment was like and how the people who lived there used that environment before the Spanish arrived. The point in history when the Spanish took over Tenochtitlán and decided to build a Spanish city on the same site is a pivotal point in how the Valley of Mexico would be used and how the resources could support the people who lived there. Many believe that the Spanish should not have chosen to live in a water-based area, dogged by floods and lack of fresh water, as they were not used to such conditions and did not know how to react to them (Gibson 1964; Simon 1997).

The choice by the Spanish to build a city in the same site as Tenochititlán, I believe, is one of the reasons for the modern-day environmental degradation in the MCMA. When the Spanish arrived in the Valley of Mexico, they brought with them a very different way of life and a very different way of looking at the world. The Aztec, like many of the other tribes that lived in the area, used the resources in the Valley to a certain extent in order to survive. I do not claim to believe that either the Aztec or many other so-called Indian tribes lived in ecologically sound or sustainable manners, though this is a common myth in our modern society. When the Spanish arrived, the Aztec were straining the environment where they lived. Clearing the land for agriculture and cutting down trees for lumber had caused increasing erosion; also, hunting had thinned the local animals (Simonian 1995: 26). However, the area was definitively not on the verge of ecological collapse. The Spanish, unlike the Aztec, changed the environment in the Valley of Mexico and Mexico in general on a grand scale that no other civilization had managed to do before (Simonian 1995: 27).

Conservation policies of the early Spanish settlements were mainly based upon economic considerations (Simonian 1995: 29). I would argue that the Aztec, though in no way having a perfect environmental track record, would have conserved different resources than those that were important to the Spanish because they needed certain resources in order to survive. The Aztec did not look at economic considerations first; they looked at the world more as something beyond their control and worried that in harming nature beyond a certain point they would harm themselves and the existence of their civilization (Simonian 1995: 28). The Spanish had demystified and disempowered nature. Like most of the rest of conquering European nations, the Spanish believed that they could alter nature without any harm coming to themselves (Simonian 1995: 28). The Spanish rarely adopted Indian styles in dress or design, house construction or agriculture, though Indian methods had been proven to work well for the earlier civilizations (Gibson 1964: 8). Spanish styles were exaggerated by the newcomers, and these may not have been the best choices for an area that was so different from what these Spaniards were used to. The outlook these Spanish settlers had was obviously a very different way of looking at the world than the Aztec perspective. I think this really did have a negative effect on the area in question, and that the reasons that the problems in the MCMA are so bad today is partially based on the beliefs about the world that the Spanish had as they arrived in the New World.

This belief is borne out in the policies that the Spanish made. Forest resources were of immense concern because they were needed in large amounts for ship-building and other important construction (Simonian 1995: 36). Other renewable resources that were important for the economic growth of Spain were also conserved to some extent so that the Spanish could continue to benefit from the use of these resources. Other resources, though, including wild animals, soil, and, most importantly for my topic, water, were not viewed as important and so not protected (Simonian 1995: 29). According to Simonian, "Spanish water law focused on the allocation of water rather than the elimination of its wasteful use" (1995: 30). There were attempts made by the Spanish to require unused water to be returned to the source and attempts were made to not lose water in irrigation practices. However, there is no indication that the Spanish worried about how irrigation would affect the soils and no thought given to the possibility that the water could run out (Simonian 1995: 30). The way the Spanish began their permanent stay in the New World was to not give attention to water quality or quantity problems, and now these problems are unmanageably large. Obviously, these problems did not diminish as the years passed. As the reader will see, the water problems in Mexico City and the urbanized areas surrounding the City within the Valley of Mexico have only increased along with the population.

The Mexico City Metropolitan Area, located in the Valley of Mexico and encompassing sixteen counties (see Figures 6 and 7), is an area of high urbanization that includes part of several states and is one of the largest cities population-wise in the world (Mazari and Mackay 1993: 794). According to Anton, the population of this area increases by 500,000 people each year from births and immigration, which is an astounding amount of people (1993: 117). The population of the MCMA is expected to be over 25 million by the year 2000 (Mazari and Mackay 1993: 794). This high population has had a drastic effect on the water quality and quantity issues in this area. One of the biggest reasons is because the Mexico City Aquifer underlying the Valley is the source of 70 percent of the water used by the people and industry that are currently in the MCMA (Monteverde 1991: 49). Though other water is being brought in from other near-by basins (Mazari and Mackay 1993: 794), the pressure on the aquifer is astoundingly high and it is not able to recharge the amount of water that is used each year by the masses of people, both in their homes and in industry. Why does this matter to so much? More than anything, it is because this problem is the biggest that the MCMA faces, as it is causing the city to slowly sink.

A discovery was made in 1846 of potable groundwater under artesian pressure (Joint Academies 1995: 12). This artesian pressure makes it so that the water trapped in the ground naturally moves towards the surface when a hole is drilled, and little or no pumping is needed. The natural springs that the Aztec had used and the Spanish continued to use for a water source flowed because of the artesian pressure and came from the Mexico City Aquifer. Though the Spanish had rebuilt the aqueducts after they took over the city in order to continue to use the springs as a source of water, more water was needed (Joint Academies 1995: 12). The artesian wells that were dug provided a very cheap source of freshwater for the people in the MCMA. Porfirio Díaz, the president of Mexico between 1876 and 1911, worked towards modernizing the country. By modernization I mean that Díaz helped Mexico to make economic advances. Electricity became a mainstay in cities, railroads were built and crisscrossed the country, and exports boomed (Kandell 1988: 353). This time of industrial revolution in Mexico is why Mexico City's population doubled during the period of Díaz' presidency

Figure 6: Aerial View of Mexico City and Surrounding Areas

(Anton 1993: 114)

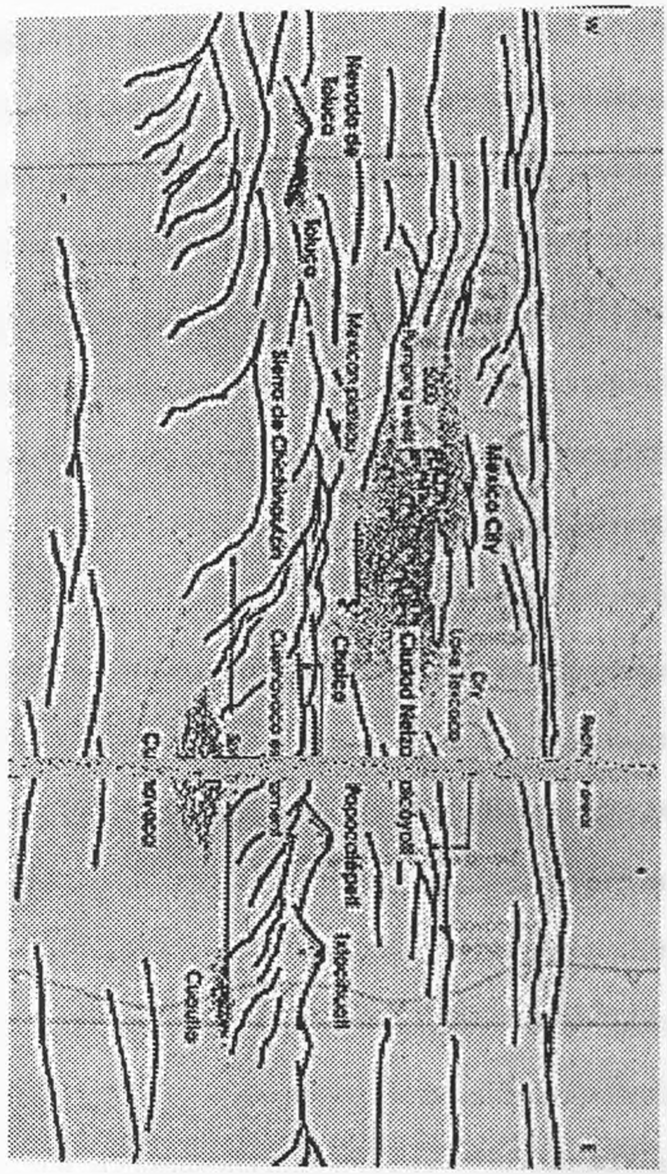
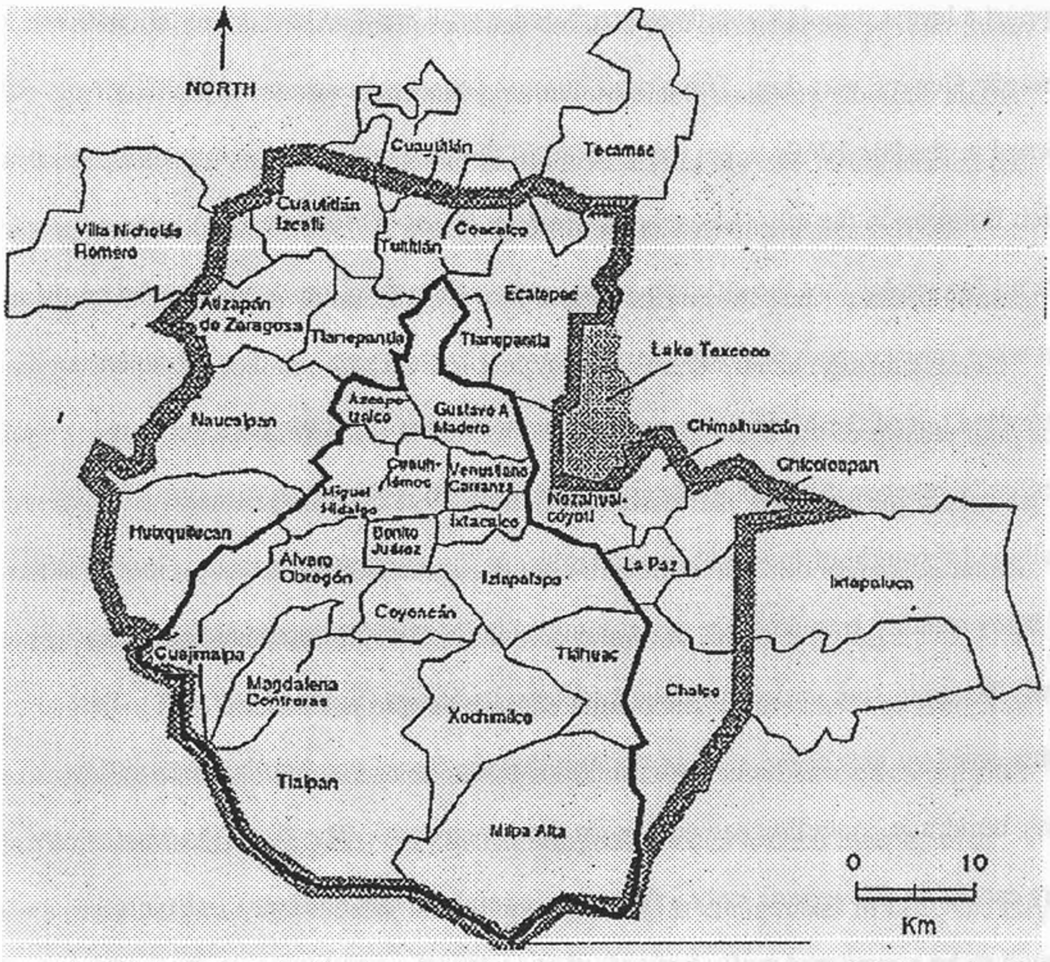


Figure 7: The Areas the MCMA Encompasses

(Joint Academies 1995: 5)



(Kandell 1988: 354). The cheap artesian wells were needed more than ever, and over the next decades many more wells were drilled to get water to the ever-burgeoning population.

The wells that gave Mexico City the ability to use more water and to support a larger population only exacerbated a problem that had begun when the Desagüe General was dug. The closed interior drainage basin was artificially opened in the late 1700s to get rid of more of the lake water that was causing so much flooding in the city (Mazari and Mackay 1993: 794). I would like to remind the reader that the city had been purposefully built on those very lakes that were causing such problems for the people living there. Today the water is channeled out of the basin along with the wastewaters from the City, and eventually reaches the Gulf of Mexico (Anton 1993: 117). The desagüe continued throughout the eighteenth century in the attempt to stop the floods. As the lakes steadily retreated, the water content in the soil decreased and the city slowly began to sink under the weight of large buildings (Simon 1997: 67). Part of this problem was based also on the fact that the Spaniards had built many heavy buildings, including cathedrals, on the spongy soil. The Aztec had been more careful in this regard; only a few temples and palaces had been built large enough to be considered really heavy in that civilization, and the majority of the population was forbidden to build more than one story on their houses (Simon 1997: 63). The Spaniards began to notice structural damage as their palaces and churches began sinking because of their weight and the loss of water content in the soil took its toll (Simon 1997: 67).

By 1925, the groundwater extraction and desagüe had led to a subsidence in the MCMA by at least 1.25 meters (Mazari and Mackay 1993: 795), and other references, such as Simon, quote even larger numbers. The first signs that this problem was going to be very serious were in the 1930s, when the natural springs that had been used for centuries as a source of water dried up (Joint Academies 1995: 12). Ironically, no one could figure out what the problem was. No one knew why the city was sinking, even though it was very obvious that it was occurring. Deeper wells and increased pumping in the late 1940s caused the city to sink several centimeters a year in some of the urbanized areas (Joint Academies 1995: 14). A subsidence of a few centimeters a year, while it sounds like a very small amount, actually has a very large impact on an area and causes huge amounts of structural damage to buildings. The damage is even worse than at first imagined because most of the buildings and areas that are subsiding do not all sink at the same rate. Buildings begin to skew, concrete buckles and metal bends as part of an edifice sinks while the rest of it does not.

By 1953, it had been proven that the subsidence of the city was linked to ground water extraction, and some of the wells in the most urban areas were shut down (Joint Academies 1995: 12). However, other wells were drilled in what were more outlying and, at that time, less populated areas in order to keep the city supplied with water (Joint Academies 1995: 14). This has resulted in the sinking of buildings and land in those areas, also. During this same period, Mexico City and its surrounding areas were becoming an "imperial city" like Tenochtitlán, with people pouring in to live there and offer cheap labor (Simon 1997: 69) as the economy of Mexico boomed. Though the problem of the sinking city was now clearly linked with overuse of the aquifer, the government did not want to hear it.

The great industrialization was underway, and the MCMA began its biggest stage of expansion ever. The pumping of huge amounts of water out of the aquifer was continued in order to sustain the population and industry (Simon 1997: 69).

The effects of the subsidence of the city, which continue today, are drastic and, in my opinion, very frightening. I want to impress upon the reader that this really is a huge problem that the MCMA faces, and it will not be easily fixed. In 1991, the volume of water extracted from the aquifer exceeded the replenishment of those waters by nearly 13 percent (Monteverde 1991). Part of this, of course, was made even worse as people started settling in the transition zones where the aquifer was recharged. This was begun because newcomers could not find places to live in the crowded urbanized areas (Simon 1997: 82). As the reader knows, when a once non-urbanized area is paved and trees cut down, more water runs off and less percolates into the aquifer.

Buildings continue to bend at odd angles and fissures open in the ground from the sinking (Simon 1997: 87) today. In the Zócalo, the main square in Mexico City, I saw a cathedral in which a person can barely enter and is under intense construction because the sinking has affected it so much and tilted it so far from the horizontal. Some of the biggest problems are caused because as the city sinks, water and sewer pipes bend and eventually break. This means that 30 percent of usable water is lost underground as pipes rupture (Simon 1997: 87). The Joint Academies Committee on the Mexico City Water Supply estimates that the average decline of ground water levels range from .1 to 1.5 meters per year (1995: 13) and that the net subsidence of the urbanized areas in the last 100 years has lowered the central MCMA by an average of 7.5 meters (1995: 14). This is not just in the past; the problem continues today and becomes even worse when earthquakes hit the area. The foundations of buildings are already weakened and even more vulnerable to collapse in the shaking that ensues and people are very much in danger (Simon 1997: 61).

In response to the subsidence, the Mexican government has spent a large amount of money and energy on bringing water into the MCMA from other, outside sources. They started a project in 1951 to bring in water from the Lerma River, and in 1974 from the basin of Cutzamala. At that time, large amounts of money were coming in because of the exportation of oil that had been discovered in many areas of Mexico, and the future of the country seemed bright (Simon 1997: 83). The government had no qualms about spending exorbitant amounts of money to get the water to the city. The idea of importing water had been used before; Los Angeles brings in water from the Colorado River from 250 miles away. However, the MCMA is at a much higher elevation than any surrounding areas, and the water has to be pumped uphill and over even higher mountains before it can reach the valley, which is nothing like and much more costly than the Los Angeles situation.

The Lerma River, fed by Lake Chiconahuapan and a series of fresh water springs, was the first to be used by the Mexican government to try to solve the water problem of the MCMA. In 1951, the water was sucked up from pumps sunk in the ground near the small town of Almoloya and piped into the Mexico City area through a long series of pipes and tunnels (Simon 1997: 70). The springs soon stopped running and the lake steadily shrank as the great city quickly slurped up the extra water. This water only helped to relieve some of the water woes of the MCMA for 15 years (Simon 1997: 71). In response to that, tunnels, aqueducts, canals, and power plants were built in order to complete the colossal task of getting water to the inhabitants of the Basin of Mexico from the Basin of Cutzamala (Simon 1997: 83). It takes a total of six percent of the MCMA's total energy consumption to bring that water over the mountains from the Cutzamala basin, and the water only amounts to less than one-fifth of the total volume of water used (Anton 1993: 117). Even worse, the resources in the other basin are beginning to be exhausted. Finding other outside water resources will be even more expensive and it is getting more and more impractical to do so (Anton 1993: 117). Also, the inhabitants of Mexico City and the surrounding areas still have extremely inexpensive water; the government picks up 60 percent of the tab for every liter of water used, and that creates a huge budget deficit (Simon 1997: 86). From my point of view, that only makes the problem worse as people and industry cannot realize the extent of the problems with or the true cost of water if the government continually pays for the majority of the water costs.

The problem with subsidence of the MCMA is only one water problem that exists in this area. It is a problem of water quantity, with the amount of people in this hugely urbanized area needing steadily greater amounts of water. Today, the estimates of the population of the MCMA top 22 million inhabitants, with approximately one-seventh of the nation's population living in this one area (Simon 1997: 72). Also, as the several million slum dwellers begin to be connected to running water, it is very likely that their consumption will increase, not decrease (Kandell 1988: 574). As I have mentioned before, the MCMA is the center of industry in the country. Industry consumes large amounts of water, which puts an even greater strain on water supplies (Joint Academies 1995: 54), and worsens quantity issues. I am sure that it will not surprise the reader to learn that these water quantity issues are not the only ones that are affecting the MCMA today. Water quality issues, which lead to problems with human health, abound because of the high population and industrialization of the area. It is these issues that will be my next area of discussion.

The potential for the aquifer underlying the MCMA to become contaminated is a definite possibility, and would decrease the amount of potable water the inhabitants have available to them. According to Mazari and Mackay, there is no certainty that the ground water is currently being polluted, but they say that there is definitely a great potential for effluents to reach and enter ground water supplies (1993: 794). Petroleum refining, gasoline stations, electronics industries and other industry are all present in the MCMA, and these all could be potential sources of groundwater pollution (Mazari and Mackay 1993: 799). The areas surrounding such industry should be studied to determine the pollutant content in the soil and waters. If the pollutants have entered the soils, it is very likely that they have percolated into the groundwater system. The reader can refer back to the first chapter for information on problems that arise when groundwater becomes polluted and the difficulty that exists in correcting the problem.

Wastewater is also a source of potential groundwater pollution, especially as 26 percent of the population of the MCMA has no sewer service (Mazari and Mackay 1993: 799), including areas in the aquifer recharge zones. The sewage created here is then locally disposed of, and there are strong possibilities that pathogens and other contaminants will migrate into the aquifer. Also, the waste water system in the MCMA includes three unlined sewer canals, and in storms these canals tend to overflow (Mazari and Mackay 1993: 800). Both the lack of lining and the potential for overflow could lead to contamination of the ground waters. The problem of wastewater is large indeed. The MCMA produces 23,200 gallons of raw sewage and industrial waste each second, and all this must be gotten rid of in some way (Simon 1997: 73).

The Gran Canal is one of the main canals that transports sewage and wastewater out of the main urbanized areas of the MCMA (Simon 1997: 73). "All the sewers eventually discharge into main interceptors of the general drainage system" (Joint Academies 1995: 26), and eventually the wastewater goes through four man-made exits in the northern end of the basin (1995: 28) and flows into rivers that ultimately lead into the Gulf of Mexico. The water, blackened with sewage and chemicals, flows down the Gran Canal, carrying its stench and possible health risks through neighborhoods (Simon 1997: 73). People actually live along the banks of the canal, and do not really have a choice in the matter. They have to live somewhere, and the poorest are the ones who end up living in the shantytowns along the river of sludge (Simon 1997: 74).

Only about 10 percent of the wastewater in the MCMA is treated, and this water is used in water reuse projects to recharge ground water in some areas and for some irrigation (Joint Academies 1995: 28). The rest of the water is untreated, and this wastewater is used to irrigate farmland in areas surrounding the MCMA on the way to the Gulf of Mexico (Joint Academies 1995: 28), often being used to grow vegetables. In a 1992 study, the United Nations found extremely high levels of arsenic, chromium, nickel, and other minerals which could have possible health effects on a person who was to eat the raw vegetables (Simon 1993: 74). The risk is not certain, but it logically follows that health risks are possible to people who eat food grown in areas irrigated with raw sewage. Also, the people who work with the raw sewage in their fields suffer from health risks, and cholera outbreaks occur periodically. Most of the farmers, though, are willing to live with the risks because the sewage fertilizes their fields, which in turn provides them with an income (Simon 1993: 75).

Leaks in the distribution system because of ruptured sewage pipes from the subsidence in the MCMA is another source of contamination. When the soil is permeated with the sewage, leaky water pipelines can be infiltrated by the contaminated water when the pressure in the pipes is low (Joint Academies 1995: 46). Independent studies over the last decades have all come up with the fact that many of the water samples from tap water in various places in the MCMA have unacceptable levels of pathogens and other bacteria (Joint Academies 1995: 47). Household water tanks can also become contaminated, as the proper levels of chlorine are not used and the tanks may not be cleaned properly nor often enough. It should be apparent to the reader that all these things will have some health effects on the human population of the areas that have such poor water quality.

Infectious gastrointestinal diseases are a major water-related health concern within the MCMA, as in the rest of the country (Joint Academies 1995: 49). Many people, especially children, are vulnerable to these diseases, and acute diarrhea and even death can result from them (Joint Academies 1995: 49). As many travelers know, non-natives should be especially careful because their bodies are not ready to take on these pathogens, and they can become very sick from drinking contaminated waters. Cholera is also a problem, which can be fatal. Because of poor water quality, the people who live in this area, and of course the population is still growing, are in danger of having their health very negatively impacted. The problem is worse in the poorer areas, as the people there may or may not have running water and have no other choice but to drink whatever kind of water is available, whether it has been properly treated or not (Joint Academies 1995: 56).

When one adds up these problems, all water-related in some way, it becomes obvious that the problems that the MCMA faces are immense. The city continues to subside, the population and amount of industry expands, and water quality can be so poor it can actually make people become ill. The problems need to be faced and remedies sought. The Mexican government, though it got off to a slow start by not wanting to believe that these problems were as big as they were (Simon 1997: 77), has begun to work on projects and create policies to help solve some of these water problems. In the next chapter, I will review these policies to see what is being done in the MCMA as we edge towards the 21st century, and how these policies came about.

CHAPTER FOUR

The Government Response

Over the last few decades, the government of Mexico has been working to try to solve some of the environmental problems that the nation faces. New policies are being passed and conservation projects are being started all over the country. In the Mexico City Metropolitan Area, particularly, water issues are being focused on for obvious reasons, as well as other environmental issues. People have begun to realize that water is a resource that needs to be protected and managed in a sustainable fashion, so humans can continue to survive in the Valley of Mexico. However, this is a relatively new occurrence and the water problems of the MCMA were allowed to reach a horribly bad state before the government responded with policies to help turn the problems around. Why is this? I think one of the main reasons may be because of the economic boom of the mid-twentieth century and the subsequent collapse of the Mexican economy.

Mexico experienced an economic boom from the 1940s through the 1970s. Mexico went through a period of rapid industrialization and, especially throughout the seventies, was seen as a so-called "economic miracle" (Janetti-Diáz et al. 1995: 175). Sadly, this boom left no room for good environmental policies.

Environmental degradation has been intense, as I am sure the reader can tell by my brief outline of merely the water issues that some portions of the country faces. The main problem was that the model of development that Mexico had followed since the mid-1930s was intended mainly to support industrialization (Janetti-Diáz et al. 1995: 175). The policies that the Mexican government passed during this period of its development were mainly made to protect foreign industry and the national private sector. There were low tax rates, agriculture primarily to support industry, and cheap energy rates (Janetti-Diáz et al. 1995: 176).

This strategy of the Mexican government achieved quantitative growth for the nation. Industry was concentrated in a few areas, especially in Mexico City, and the ecological costs were not taken into account (Janetti-Diáz et al. 175). Little attention was given to the agricultural sector of society, and the rural poor overexploited resources in those areas in an attempt to survive, while the urban upper and middle classes in the cities had their consumption of natural resources subsidized by the government to stimulate that very consumption (Janetti-Diáz et al. 175). The reader can clearly see that problems of overconsumption and ecological degradation spring from these policies. What makes it worse is that there were no environmental public policies to protect natural resources. The problems stemming from the degradation of the natural environment were largely ignored into the late sixties (Janetti-Diáz et al. 175), by which time much of the damage had already been done.

Between 1940 and 1970 the population of Mexico grew from twenty million to forty-eight million, and the number of Mexicans living in urbanized areas rose from four million to twenty-four million (Simonian 1995: 111). It was during this time period that Mexico City, and the MCMA in general, became the "cultural, economic, and industrial center for the nation" (Joint Academies 1995: 1). There was a huge migration of people from the rural areas moving to the big cities in search of work so they could eke out a living. This was especially true for people from the agricultural areas who were unable to support their families through agriculture. The people settled illegally on the margins of the urbanized areas, such as along the Gran Canal where it is unhealthy to live, and the water supply network and sewage system could not keep up with the growth (Joint Academies 1995: 1). Industry also "settled" in the MCMA, with forty-five percent of all Mexico's industrial activity occurring there (Joint Academies 1995: 4). Simonian points out that the "excessive concentration of people and factories in Mexico City. . . culminated in massive pollution problems" (1995: 111). Clearly this statement includes water quality issues, and water quantity issues are implied just by the sheer number of people and factories.

Even though it was obvious that water in highly urbanized areas like the MCMA needed to be protected, the Mexican officials viewed any water not put to productive use as wasted (Simonian 1995: 111). It was acknowledged that some conservation measures were needed to stop loss of water from unlined canals and other such wasteful structures (Simonian 1995: 111), but little attention was really given to these measures and no policies were enacted. Economic arguments were the only ones that would get any results, and the officials that cared to worry about anything else were few and far between. Through that entire era in Mexico, there was never a conservation-minded president and a strong conservation agency that occurred at the same time, and, in general, Mexican conservation was abandoned all together (Simonian 1995: 131). It is clear that this would have had some effect on the water issues that I have been discussing in this paper. In a time of industrialization and economic boom that lasted in Mexico for over thirty years, no real environmental protection policies were passed. Of course this would exacerbate the problem and the growth of centralized, urban areas went on without obstacle.

Not until after the economy collapsed in the late 1970s because of an internal and external economic imbalance (Muñoz 1997: 119) did any kind of conservation work begin. At one time characterized by stability and growth, the economy collapsed largely because of the toppling of oil prices and the increase of international interest rates, and Mexico's national debt became huge (Muñoz 1997: 119). Without a strong economy, and so a strong argument to fend off any criticism over lack of environmental policies, people began to form social movements in response to the environmental problems that the nation was facing and that was effecting their lives. Since the 1980s, after decades of having really no non-governmental organizations (NGOs) of any note, a very significant number of conservation-based NGOs have emerged in Mexico (Janetti-Diáz et al. 1995: 190).

With the growing national awareness of environmental issues that began in the 1980s, the number of NGOs created to confront these issues that exist in Mexico is steadily increasing. These NGOs are extremely diverse in nature, but the shear number of them does help to make the nation even more aware of the environmental problems that it faces. It is the NGOs that are a main force in driving the federal government to begin to face the environmental problems that abound in Mexico, and so are very important in this regard (Janetti-Diáz et al. 1995: 190). These young organizations do not have much strength to create change in the country other than keeping the people aware of the problems and the government aware that the people want change. They do not have any actual political clout. However, the simple fact that they keep the environmental movement a public concern and hold the government organizations responsible for actions that negatively impact the natural environment and the people who live in it is a huge step (Janetti-Diáz et al. 1995: 191). The water issues discussed throughout this paper are one of the big environmental issues that the country faces, and the NGOs help to make the rest of the country aware of these problems.

The first time environmental issues in general were placed on the national political agenda in modern times was in the early seventies by President Luis Echeverría[1]. Though he believed that some change was needed to stop the intense environmental degradation, he was steadfast in the commitment that the federal government had to continue its work towards the industrialization of the nation (Simonian 1995: 178). The first Mexican environmental law, the Federal Law to Prevent and Control Environmental Pollution, was issued in 1971 by Echeverría

[1] The government of the Republic of Mexico involves three branches, the executive, the legislative, and the judicial, much like our own system of government. The President is elected by a direct and secret popular vote and serves for a term of six years. He does not need to be ratified by the Senate or the Chamber of Deputies in the conduct of his affairs, and can appoint and dismiss cabinet members at will (Banco Nacional 1960). The legislative branch of the government of Mexico involves two houses, the Senate and the Chamber of Deputies. The representatives are elected by direct vote from each state and the Federal District, and are responsible for passing laws that will be enforced throughout the nation. Each of the 29 states has a sovereign government that mirrors the federal government. Though I am sure that all this basic information about the government is true, the impression that I got when I was in Mexico was that there is a lot of corruption within the government which is not regulated. I heard rumors, also, that the "direct and secret" elections were not quite so above-board. Another interesting note: the same political party has been in power since 1938.

and had several provisions regarding water, air, and land pollution (Janetti-Diáz et al. 1995: 176). This was in response not to the nonexistent NGOs and grassroots movements of those times, but to health officials, academics, and private citizens worried about the severity of the environmental problems and how they would affect general health and the economy (Simonian 1995: 178). It was a good first step, though it did little to change anything. The law was poorly enforced, for one, and was under the jurisdiction of the Ministry of Health and Welfare (Simonian 1995: 181). The law proposed technological remedies to the problems, not any change in how the society operated as a whole (Simonian 1995: 180). Also, it did not insist that multinational corporations obey the environmental laws (Simonian 1995: 179), and so major industries from other countries continued to put emissions out into the environment unchecked.

It was not until 1983 that a governmental organization was formed to make environmentally-based policies that was not under the jurisdiction of the health sector of the federal government (Janetti-Diáz et al. 1995: 177). This was due to newly-elected President Miguel de la Madrid. The Secretariat of Urban Development and Ecology (SEDUE) was created in response to the economic collapse of 1981/1982 in order to show the Mexican people that the administration was concerned with the environment (Janetti-Diáz et al. 1995: 177). President de la Madrid incorporated environmental issues into his National Development Plan. De la Madrid was the first to "devote attention to the beleaguered environment" (Mumme and Sanchez 1992: 466) and he must be commended for this. However, according to Simonian, de la Madrid did not effectively regulate harmful environmental activities, especially when they were government-perpetuated (1995: 185). The new laws were vague on specific mechanisms of enforcement, and with no real follow-through environmental progress faltered (Mumme and Sanchez 1992: 466). Luckily, the environmental progress did not stop altogether. This is largely because the succeeding president, Carlos Salinas de Gortari, broke with past norms and left the basic structure of environmental administration the same as his predecessor (Mumme and Sanchez 1992: 467).

Carlos Salinas began his six-year term in 1988. A poll in 1987 of citizens of Mexico City had placed the environment as second or third on a list of public concerns (Janetti-Diáz et al. 1995: 177), and the Salinas administration attempted to respond to the wishes of the public. It was under Salinas that the National Water Commission (CNA) was established, which has full authority in all water management matters (OECD 1998: 63). This organization was established because of the Clean Water Program that was put into place in April of 1991 (Juan et al. 1995: 26). This program outlined some objectives that needed to be achieved to better the water situation of the country. This list of goals included disinfecting water for human consumption, the monitoring of water quality, and control of how unclean water is used in horticulture (Juan et al. 1995: 26). The CNA was put in charge of the program and has been working towards the sizable goal of having clean water for the humans in all parts of Mexico.

The most important environmental development that came out of Salinas' time in office was the National Policy on Ecology and Environment (Janetti-Diáz et al. 1995: 177-8). This policy stresses that environmental protection is based on the concentrated efforts of all people in Mexico, including the government, individuals, and social organizations. It also encompasses a "polluters pay" principle, with the common good of the environment dominating private rights. This is an attempt to "harmonize economic growth with the preservation of environmental quality while advocating the conservation and rational use of natural resources" (Janetti-Diáz et al. 1995: 178). What I understand it to be is a broad policy embracing long-term preventative activities to reverse some of the worst environmental problems, while not endangering economic growth. Any environment-protecting project begun must fit within the principles listed in the National Policy. For particulars on the Salinas administration and the national environmental policies that were passed during that administration, I would recommend reading Mumme's 1992 article, as well as Mumme and Sanchez's 1992 article. These articles outline the environmental policies and programs of the Salinas administration in great detail. These national policies and movements that I have been discussing are relevant, as water policies of any area are generally based on these national policies. However, I must now refocus on the MCMA and what policies and programs are being implemented in that area to solve the water quantity and quality issues, and so must leave the Salinas administration for another time as I forge ahead.

One thing that has to happen in the MCMA and is currently being worked on is to change the way water use is viewed by the general public. Historically, the principal has been that "water resources are the property of the state and thus should be a free, constitutional right for every citizen" (Joint Academies 1995: 71). This is based on Article 27 of the Mexican constitution, established in 1917. To me, this seems out of date. The public often interprets this article, I think, to imply that the water should be given to them free, while the increased pressures on water resources dictates that this cannot be so. In Mexico all water resources are public property controlled by the Federal Government (OECD 1998: 62). In fact, it is the President himself who is granted the power to regulate extraction and use of the nation's water. This means that it is the federal government that establishes rules for both where water can or cannot be extracted and in setting rules of water use permit issuance (Joint Academies 1995: 72). I feel safe to say that this is not the best choice, as it is the people and government of an area who understand better what is happening in that region. Some recent reforms, then, have involved a promotion of private water rights and the privatization of the management of the water supply and wastewater services (Joint Academies 1995: 71). The goal behind this change is to improve the management of water in the MCMA and to hopefully create a cultural appreciation of the water as a limited resource for which people must pay (Joint Academies 1995: 73). I see this as an attempt to make the citizens of the area and of the nation aware of how costly the water extraction is, and how important the water is for the city's continued existence.

I would like to remind the reader that the MCMA stretches across more than one state, and many of the biggest projects being worked on often only involve the Federal District and not the large portion of the MCMA that exists in, for example, the State of Mexico (see Fig. 6). The Federal District has 16 counties that are a part of the MCMA and all or portions of 17 counties in the State of Mexico also are contained within this urbanized area (Joint Academies 1995: 4). All parts of the MCMA are working towards new water policies because the problems exist everywhere, but it is important for the reader to remember how big this area is as I discuss policies in the MCMA. I will explain this in more detail and discuss how it affects the strides being taken towards fixing the water problems in the next chapter.

One result of the Federal District Privatization Decree, issued in 1992 under the Salinas administration, was to raise water fees in Mexico City by 400 percent. Before the decree, the residents of the MCMA paid one of the lowest water rates in the world (Simonian 1995: 192). Officials understand that water conservation is the only alternative to pumping water in from distant valleys at a high economic and ecological cost. As the privatization decree was made, local water commissions had already been taking some of the tasks from the National Water Commission. This is definitely another step to decentralize water management (OECD 1998: 63) .

The private firms that won the bids to manage the water distribution and billing in the Federal District are going about making sure the cost of water reflects true costs in three ways (Joint Academies 1995: 73). The first stage is to update customer registers and to install meters to insure that all water being used is properly measured. The second stage is to bill customers by metering their usage. Private firms will undertake the maintenance and repair of the distribution in the third stage, and, at that point, will be in control of selling the water to the final customers (Joint Academies 1995: 74). What this will do is make it so the companies, if they want to make money, will be sure to collect bills and to stop leaks. If they do not do these things, they will be losing money. This will take much coordination and cooperation between the private companies, the Federal

District, and both the National and Mexico City Water Commissions to insure that the privatization will work smoothly (Joint Academies 1995: 74).

A new law on water rights was passed in 1992 that was a big change in how much water will be pumped from any given area in the MCMA (Joint Academies 1995: 74). What this law does is make it so a basin can be said to be fully appropriated, meaning that all the water that should be used is already being used. No new wells can be put into a fully appropriated basin. Instead, anyone who wants to use the water must purchase the rights of an existing user (Joint Academies 1995: 74). Obviously, this will help lower what has been a steady increase in the amount of water pumped out of the aquifer. The addition of meters will help this law to function, as currently no one is certain how much each user is getting from their various wells. This method will be based on actual studies on how the aquifer is doing, how much water is being pumped out, and how much water is available. Because of these things, this method will be much more accurate and based on what is actually occurring in the area (Joint Academies 1995: 75). In addition to this, programs have been put into effect to retrofit low-flow plumbing fixtures and repair system leaks (Joint Academies 1995: 55), which are other ways to achieve the end of lowering the amount of water that is being pumped out of the aquifer.

There also have been a few steps taken to fix some of the water quality issues that are evident in the MCMA. Emissions must be reduced for human health reasons. One thing that is happening along these lines is to increase the access of sanitation, such as sewage networks, in the urban areas (OECD 1998: 74). This is based on the Clean Water Program of 1991. The Program has provisions so that there will be work towards disinfecting tap water, improving the operation of waste water treatment plants and prohibiting use of untreated waste water for irrigating crops that are to be eaten raw (OECD 1998: 73). Hopefully, this will help to decrease the amount of human waste that is released into the water systems. The Program is most important in the poorer areas, as often these people are not hooked up to any kind of sewage system and are most in need of better water quality (Joint Academies 1995: 64). The general health of these people is at stake. The Ministry of Health is in charge of ensuring that drinking water quality is within set standards (Joint Academies 1995: 76). The General Health Law, made in 1984 and still in effect, prohibits the discharge of wastewater into areas where potable water is taken in. At this time, however, there is no comprehensive set of water regulations, mostly because the state and municipal agencies have little responsibility for the water quality, and regulations are inconsistent (Joint Academies 1995: 76). Work continues to be done by the National Water Commission and the Ministry of Health in order to fix these problems, though many standards are still based on an outdated 1971 law (Joint Academies 1995: 76).

Industry is an important sector of water users that must be addressed in order to stop some of the effluents being released and to improve water quality in the MCMA. As the reader knows, a large number of industries are based in the MCMA, and these have the ability to release effluents of all kinds, including acids, grease and oil, and heavy metals, into the water systems (OECD 1998: 59). According to the OECD, only 8 percent by volume of industrial waste water receives any kind of treatment (1998: 72). New effluent limits were drawn up with consultations from the industry taken into account. One thing that has come of this is that industry is often allowed a grace period for how soon they must meet standards; for small dischargers this can be as long as 13 years (OECD 1998: 72). To balance this and to make sure that this is not just leniency towards polluters, the government has begun to perform more rigorous inspections, to improve the collection of pollution fees, and to encourage greater public participation in policy making (OECD 1998: 72-3). A new tax is also in effect, which will work like a permit fee and is supposed to generate revenues to support protection of water resources. This is a disincentive for polluters, who will get a severe fine for putting untreated waste water into the drainage system (Joint Academies 1995: 77). However, less punitive measures are also being used in an attempt to coax industry into complying instead of just punishing them when they do not comply (OECD 1998: 72). This is comparable to the positive rewards a child might get when she does something right and not just punishment when she does something wrong. In such a situation this can be very effective, and I hope it will prove to be at least somewhat effective on a larger scale.

The subject of governmental national and local action is not easy to discuss or fully understand. I have attempted to explain some of the projects and policies occurring in the MCMA to address the water issues that exist there in ways that make it clear to the reader some of the things that are being done. I did this, though, on a basic level so that the policies and projects can be generally understood while not getting too far into the confusingly large amount of laws made, laws repealed, and laws seemingly forgotten about. I did not go in to as much detail as is possible on this subject. For more complete information, I would recommend that the reader do a more intense study of environmental laws and policies in general so that she can understand how the specific water policies and management strategies have come about. There is more information out there on these topics, and it is fascinating and complex. Many of the laws I have mentioned are for the entire nation and not just the MCMA, and so effect more of the nation than just this area.

In the next chapter, I will provide some recommendations for what should continue to happen in the MCMA and what might not be working there or might need some revamping. While I do not consider myself an expert on this subject, I feel that I can give sound recommendations based on my understanding of the policies and what other organizations have thought about the policies. It seems very important to me that a nation does not simply believe that passing new policies will change everything and fix the problems. The policies and projects need to be continually examined to see what does work, so that successful policies can be used in areas with similar problems. I hope the Mexican government does pay attention to valid recommendations made by outside organizations so they can work towards addressing the issues in the best possible ways. If the problems of the MCMA are to be successfully addressed, the policies that work best should be continued and what does not work should not be bothered with. The water problems in the MCMA are too big to risk throwing money and time into channels that are not yielding results, and solving the water problems should be a priority.

CHAPTER FIVE

Possible Solutions and the Future of the MCMA

Based on my research of the water problems in the MCMA and on what is being done about those problems, I have formed some opinions on what needs to be continued, what should be even more focused on and what does not work or is not working to solve the water problems. In this chapter, I will examine some of the reasons why good policies are not working and what can be improved in the MCMA. I am not criticizing what I see as a sincere effort by the Mexican government in the MCMA to address the water quantity and quality issues that this urbanized area faces. However, throughout my research I have become increasingly concerned that the water problems that the Mexico City area faces may not be reversible. As Monteverde says, "This giant is condemned to die of thirst, and there is no miracle in sight" (1991: 49). I prefer not to go this far in a statement, and would rather focus on the possibilities for improvement. I hope that there will be continued life for this city and the people who live there and will try not to focus intently on the negatives and the chance that solving the water problems in the MCMA is not possible.

In the last chapter, the reader learned that though water quality issues are being addressed to some extent in the MCMA, there are not nearly as many policies addressing quality issues as there are about quantity issues. Because of higher levels of water pollution concentrations, "societal concern with the pollution problems has increased substantially in recent years" (Biswas et al. 1997: 179). This is the reason that waste water plants are being built and modernized and that a few policies are being passed. However, only about 6 percent of waste water in Mexico is currently being treated (Biswas et al. 1997: 180), and this needs to be addressed further by the nation as a whole. Sources I had made it appear to me that part of the problem is the difficulty that exists in finding a good water quality monitoring program that is cost-effective as well as reliable that can be easily used by people who have not had extensive training (Biswas et al. 1997: 180). According to Biswas et al., straight technology transfer from one country to another does not work well (1997: 180). What needs to be done is to have a framework for water quality monitoring in Mexico specifically developed for that country by the people of that country. This makes sense. Every country has its own conditions that need to be fulfilled and different specific problems that need to be addressed.

Though this is certainly a long-term way of improving the way water quality is dealt with, I feel that this is a very important step to take. Such a process is expensive, more so when it is first implemented (Biswas et al. 1997: 181). But once such a monitoring system is in place, the cost will go down and the nation will have a way of making certain that water quality is high enough to not make the population sick. Monitoring does not, of course, make the water a higher quality. However, if water is tested and found that it does not meet health standards, then something can be done about it. With such a system, each area can have the water in question examined for what is the biggest problem, be it effluents from industry or from sewage or any other source, and quality standards can be made and, with further work, met. Without knowing how big of a problem there is in an area or what effluents are causing the most problems, it is impossible to tell what kind of response should be made. The health reasons are enough to make such a long-term and expensive project worthwhile, and I feel that this should be started as soon as possible in not only the MCMA, but in Mexico has a whole.

The problem with such a water quality monitoring system, like so many projects to address environmental issues, is that it has a certain amount of expense that goes with it. Restrepo lays out a series of projects that need to be accomplished throughout Mexico and in the MCMA (1995: 16). He talks about the importance of modernization of water systems, of fixing the entire infrastructure of the water system, and of ensuring that the waters are safe to use. I agree with all of these. However, these all come with at least some start-up expenses, which must be covered by the government. I have found that few organizations are eager to start programs that will use some of their budget money. I think that a water quality system is a good way to start in on solving the water problems, as the nation cannot begin addressing the problems if it does not know where the worst problems are. As people begin to understand the problems and realize how big the water quantity issues are, there will be calls to fix the infrastructure better and to modernize the system. To me, though, the health of the people is the first part of the problem that should be addressed. A water quality monitoring system can be established to fit the needs of the country and would be a good first step towards that end.

For the nation to begin to address water quantity issues, the 74 percent of the total water usage that currently ends up as wastewater in the MCMA (Joint Academies 1995: 80) needs to be focused into more reuse projects. Most of the reuse projects will require a certain amount of treatment of the water. I have discussed problems associated with untreated waste water use already. But by reusing partially treated wastewater, the MCMA will be able to conserve the highest quality water for important uses such as drinking (Joint Academies 1995: 81). Some small amount of water reuse has begun, but more is needed. Reuse and treatment is a way of addressing part of both the water quality and water quantity issues that exist in the MCMA in some way, and I definitely think it is important. The amount of wastewater produced in the Mexico City area is extensive, and it could become an important resource for low quality water needs such as agricultural and landscape irrigation.

One of the biggest problems I see in trying to solve, or at least remediate, the water situation in the MCMA is that the MCMA encompasses more than one political area. I mentioned this briefly in the last chapter and want to expand upon it here. The crux of the problem is that the Federal District, which contains a major portion of the MCMA (see Fig. 6), is passing some policies and doing certain things working towards water conservation that other places are not doing. A good example of this is with the State of Mexico. The State of Mexico holds another large portion of the MCMA, and its policies and methods are not as far advanced as those in the Federal District. Why do I see this as such a problem?

Well, I feel that consistency is a very important part of solving these problems. From the first chapter, the reader understands that water transcends political boundaries and this lack of consistency makes it so less progress can be made towards permanently fixing the existing water issues.

If the Federal District is doing all sorts of things to solve its water problems, but the State of Mexico is not, then no problems will really be solved. If the two places are not actively working towards the same goals in the same ways, then what one place is not doing may actually undermine any progress made in the MCMA as a whole. There is no invisible boundary that stops water and water issues from traveling from one portion of the MCMA to another just because the humans have arbitrarily assigned a political boundary there. The Joint Academies Committee on the Mexico City Water Supply provides a fairly good explanation of this (1995: 61-3), and points out that both the Federal District and the State of Mexico are making progress. The State of Mexico is behind, though, in terms of implementing programs to address the water issues. In this case, like so many others, the chain is only as strong as the weakest link. The weakest link must be brought up to a higher standard so the chain can be stronger as a whole. My basic point here is that more focus needs to be given to the MCMA in its entirety so the water problems can be consistently addressed.

The idea of metering water use and making sure the cost is being met by the users is one that I feel is very good. I have already mentioned more than once how important I think it is to show the general public how much water actually costs. Though this is well underway, it must be continued. Several million meters must be installed, at a cost of roughly $100 each (Joint Academies 1995: 84).

This is a high cost, but if one balances it against the cost of importing water from outside basins or creating new infrastructure it is a much smaller total and long-term cost. As more people are hooked up to meters and water rates are made to reflect the true costs of the water, it is very likely that people will conserve water more. This can lead to sustainable water use and resource management so that the limited water supply can continue to support healthy human life in the MCMA. Sustainable water use is both "ecologically and economically rational" (Downs 1998: 166), and the privatization of water management is one way that Mexico is working towards that goal. As privatization occurs, the companies will want to get full costs back so they can make money. This money should not, however, just go to owners of companies. It should be put back into the system, fixing leaks and improving system infrastructure so that conservation is maintained and less water is wasted. With the companies knowing that they will lose money because of such wastes, I hope that they will respond by taking steps to stop these occurrences. With a limited supply of water available for the humans of the area, it must be used carefully and efficiently, and these are some ways to do it.

It is most important to meter the more well-off and the biggest users first, as "increasing the block rates of nonmetered high-volume users will shift some of the cost burden to those most able to afford it" (Joint Academies 1995: 87). This will help improve the water service available to the population as a whole as the infrastructure is improved and the system is strengthened. It is important to extend water service to everyone, so that everyone has good service and will be more willing to pay for that service. In this paper I have only outlined ways that these water issues impact the human population of this area. I think it is important to reinforce to the reader that equity does not exist for the people living in these areas regarding the impact of water problems. One of the reasons that there have been so many responses to these problems is that they are very far-reaching throughout the population. However, the situation is hardly equitable to the poor. Water is essential to human welfare and health (Joint Academies 1995: 87), and sufficient access to the resource in order to meet human needs must be extended to people of all income-levels. The MCMA continues to struggle to keep up with the increasing population and to get everyone connected to water service and sewer service. In my mind, however, this must be done to truly address the water issues and allow all people to live in the MCMA safely.

The public should also have knowledge of what is going on with their water supplies, and the education of the general public on water issues should be continued and broadened. Education is often discussed as a way to solve environmental issues, and this is no exception. Restrepo mentions this as one of the important things that need to be achieved in Mexico: the water users should participate in the administration of water (1995: 16). How can they do this without understanding the problems? The increase in the number of NGOs in the MCMA has helped with this and will continue to do so. The fact that there are nongovernmental organizations shows that some portion of the general public knows about the problems because they have managed to get people together to start such organizations. This definitely helps with education, but there is so much more to do. When I was in Mexico last summer, I noticed that there were recycle bins on every street in some of the larger cities. This is a very advanced-seeming system when compared to recycling opportunities in the areas that I live within. However, no one was aware of how to use the recycle bins, what should go in them, etc. This is a good example of the government doing something that turns out to be useless because people just do not know what it is for or how to use this. Also while in Mexico, I read an article that talked about the effort to educate children in the MCMA in order to reduce the amount of garbage produced in the city. Teaching children can mean that what is for one generation a struggle to understand and change is a way of life for the next generation. I believe that only by making the public aware of what needs to be done to conserve and protect the water resources can anything truly be accomplished.

One way that education could help to address the issues is by helping the general population learn about why water rates need to go up. Though I support the idea of raising water rates to reflect true water costs, I hope the reader realizes that this is not a popular notion among the general public. This makes it more difficult and politically dangerous for any government to raise rates. The government in power risks becoming unpopular. Many people believe that water is essential to life and so the government is obliged to bring it to the population at little or no cost (Joint Academies 1995: 67). One would hope that if people understood the reasons behind the rate hikes they would react more logically and possibly with less anger. The politics in environmental issues, and this water issue in particular, might actually be a good reason to support privatization. With privatization, there would be less politically-motivated policies and more policies ensuring that water costs are really met by the people using the water. This is a difficult thing to do, I admit, and I found that reading about a study on pollution issues and the management response in industry helped me to understand what things help people to understand a problem so that they changed their actions.

What this study found for the industry I feel can be used at a much larger, city-wide scale. Industries tend to respond more readily to economic and regulatory incentives (Joint Academies 1995: 67), but I think that some of the same strategies could be used in the general public. Important factors in industry adopting pollution control measures involves both formal and informal regulation (Dasgupta et al. 1998:1), informal regulation being community pressure. I have already outlined the importance of both those things in the MCMA, and so the similarities between industry and other scenarios already hold true. Actual programs that work in industry include environmental training for all plant personnel, and not just a "cadre of environmental specialists" (Dasgupta et al. 1998: 17). Regulatory pressure, with inspections as part of the regulation, public scrutiny and higher education of workers are all ways that helped increase the cleanliness of plants (Dasgupta et al. 1998: 18). Obviously, these are all things that would work on a larger scale, though it would be more expensive. Education is a key to environmental improvement, as is strict enforcement of policies, which leads to a higher price of pollution (Dasgupta et al. 1998: 18). I think looking at smaller examples can work well because it is easier to document change in such settings. Though not everything that can work in industry can work on a larger scale, there are definitely corollaries between the two that I feel are important to know about.

From all the information I have examined in my study of the MCMA, the government seems to be doing a reasonably good job at addressing some of the most serious issues. The problems are so severe there that they essentially must do something. One reason that I wanted to examine this topic and understand it better is because the Mexico City area is not the only area facing such problems. Guatemala City, the capital of the Republic of Guatemala, has problems very similar to those of the MCMA, as does Managua, Nicaragua and Mérida of the Yucatán peninsula in Mexico (Anton 1993). As I mentioned in an earlier chapter, places in Texas and the Midwest are also experiencing problems with aquifers not being able to support growing communities. My Valley of Mexico example is only one case among many. As the population of the world continues to grow, it is likely that more water supplies will become contaminated with unwanted chemicals and effluents and that the population will not be able to survive on the supply available.

I hope that the reader now sees how big these water problems are and how much it reflects the problems in the real world. How we "measure and manage pollution and health risks" are some of the most pressing problems we face as a world as we look towards the next millennium (Downs 1998: 166). The world is growing increasingly urbanized and industrialized. To make it worse, people continue to press into already populated area, even in places like the MCMA where environmental problems are already critical. People still go there in hopes of finding a new life and a new way to survive because they cannot do it in their original locale. In many ways, I find this very sad. In my mind I have struggled to find an answer for the problems I have learned about. I appreciate what is being done to address the water issues, and other environmental issues in this area are being dealt with in similar manners. Dasgupta et al. points out, however, that the phenomenon of environmental management is relatively new in Mexico, and so it likely that Mexican firms, as well as government, are not fully informed about strategies for pollution control (1998: 8). New ways need to be explored and the government and firms need to pay attention to others' ideas to ensure that attempts to solve these problems can be undertaken in the best ways possible.

Even if everything I have mentioned that the Mexican government can do to improve the water situation is completed, I am entirely unsure that the problems will be solved. When I presented this material to a class of my peers, someone posed the question to me about the worst-case scenario after I admitted that I did not really see how the problems would be solved. My answer? The worst case scenario that I can imagine is that people would start dying from lack of water and increased water pollution, if they are not already. The worse-case scenario is that the water issues will neither be addressed nor solved, and the natural environment will no longer be able support the human population.

With luck, this will be a long ways down the road. I wish all the best to any government struggling with such environmental issues. I discovered in my research that it is complicated to plan and to implement policies and it is a very political game. Nothing is easily solved. To drive this home to the reader, I would like to reiterate that this is only one such environmental issue that the world and the MCMA faces. Just one very important issue, that affects all of our lives. Also, I want to say again that I have only addressed how this issue affects human populations. Though it was hard for me, I have discounted the natural environment and have focused instead on selfishly human reasons for wanting the change. I hope the reader has successfully navigated through this thesis and found that she understands more about the water issues of the world in general after this look at the MCMA case. And I hope it spurs her on to find out more about her own region and what is being done to help stop this rush towards unhealthy environmental degradation.

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